YANMAR

SERVICE MANUAL

EXCAVATOR

ViO45-5(B)
ViO55-5(B)

FOREWORD

This service manual outlines procedures for servicing YANMAR construction machinery. It contains specifications, servicing instructions and handling cautions. To obtain the maximum life and performance from YANMAR construction machinery, read this manual carefully and follow its instructions.
Please note that all dimensions and numerical values in this manual are for service reference, and are not inspection standards. Descriptions and specifications in this manual are subject to change without notice due to design improvements, etc.

⚠ WARNING

California
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

⚠ WARNING

California
Proposition 65 Warning

Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.
Wash hands after handling.

CONTENTS

CHAPTER 1
General Cautions for Maintenance Work

1-1 Correct Work 1-1-1
1-2 Safety Precautions 1-2-1
1-3 Preparations 1-3-1
1-4 Cautions for Disassembly and Reassembly 1-4-1
1-5 Cautions for Removal and Installation of Hydraulic Equipment 1-5-2
1-6 Cautions for Removal and Installation of Hydraulic Piping 1-6-2
1-7 Cautions for Handling Seals 1-7-3
1-8 Correct Installation of Hydraulic Hose 1-8-3
1-9 Specifications of Hydraulic Hose 1-9-6
1-10 Air Release of Hydraulic Equipment 1-10-11

CHAPTER 2
Technical Data

2-1 Specifications 2-1-1
2-2 Outline Drawing and Working Area 2-2-1
2-2-1 Canopy type 2-2-1
2-2-2 Cabin type 2-2-2
2-3 Weight List of Main Parts 2-3-1
2-4 Lifting Capacity List 2-4-1

CHAPTER 3
Service Standards

3-1 Machine Performance 3-1-1
3-2 Engine 3-2-1
3-3 Undercarriage 3-3-1
3-3-1 Rubber Track Specifications 3-3-1
3-3-2 Steel Track Specifications 3-3-2
3-3-3 Common Specifications of Steel & Rubber Tracks 3-3-3
3-4 Controls 3-4-1
3-5 Hydraulic Equipment 3-5-1
3-5-1 Hydraulic Cylinders 3-5-1
3-6 Implement 3-6-1
3-6-1 Front Attachments 3-6-1
3-6-2 Blade Moving Device 3-6-2
3-6-3 Bucket Teeth 3-6-2
3-7 List of Tightening Torque 3-7-1
3-7-1 Machine 3-7-1
3-7-2 Engine 3-7-4
3-7-3 Tightening Torque for General Bolts and Nuts 3-7-4

CHAPTER 4
Engine

4-1 General 4-1-1
4-1-1 How to Read This Manual 4-1-1
4-1-2 Precautions for Service Work 4-1-3
4-1-3 Engine External Views 4-1-4
4-1-4 Structural Description 4-1-4
4-1-5 Exhaust Gas Emission Regulation 4-1-5
4-2 Troubleshooting 4-2-1
4-2-1 Quick Reference Table for Troubleshooting 4-2-1
4-2-2 Troubleshooting by Measuring Compression Pressure 4-2-4
4-3 Inspection and Adjustment 4-3-1
4-3-1 Oil Inspection 4-3-1
4-3-2 Cooling Water Inspection 4-3-1
4-3-3 Inspecting Water Leak from Cooling Water System and Radiator 4-3-1
4-3-4 Fan Belt Tension Inspection and Adjustment 4-3-2
4-3-5 Adjusting the Valve Clearance 4-3-3
4-3-6 Inspecting the Fuel Injection Valve Injection Pressure and Spray Pattern 4-3-5
4-3-7 Fuel Injection Timing Adjustment / Fuel Injection Pump Inspection and Adjustment 4-3-9
4-3-8 Sensor Inspection 4-3-12
4-3-9 Battery Inspection 4-3-13
4-3-10 Adjusting Operation 4-3-15
4-3-11 Long Storage 4-3-16
4-3-12 Periodic Maintenance Schedule 4-3-17
4-4 Engine Body 4-4-1
4-4-1 Introduction 4-4-1
4-4-2 Cylinder Head 4-4-2
4-4-3 Gear Train and Camshaft 4-4-11
4-4-4 Cylinder Block 4-4-16
4-5 Lubrication System 4-5-1
4-5-1 Lubrication System Diagram 4-5-1
4-5-2 Trochoid Pump (ViO45-5, ViO55-5: 4TNV88-PBV) 4-5-1
4-5-3 Trochoid pump (ViO45-5B, ViO55-5B: 4TNV88-BXBV) 4-5-3
4-6 Cooling System 4-6-1
4-6-1 Cooling Water System 4-6-1
4-6-2 Cooling Water Pump Components 4-6-1
4-6-3 Disassembly (Reverse the Procedure Below for Assembly) 4-6-2
4-6-4 Servicing Points 4-6-2
4-7 Fuel Injection Pump / Governor 4-7-1
4-7-1 Introduction 4-7-1
4-7-2 Fuel Injection Pump 4-7-1
4-8 Electrical Equipment 4-8-1
4-8-1 Starter Motor 4-8-1
4-8-2 Alternator 4-8-3
4-8-3 Air Heater 4-8-6

CHAPTER 5
Hydraulic System

5-1 Outline 5-1-1
5-1-1 Control Valve Operation 5-1-4
5-1-2 Additional Operation of Control Valve 5-1-6
5-2 Hydraulic Circuit Schematic 5-2-1
5-3 Circuit Operation 5-3-1
5-3-1 Boom 5-3-1
5-3-2 Arm 5-3-3
5-3-3 Bucket 5-3-5
5-3-4 Swing 5-3-7
5-3-5 Boom Swing 5-3-9
5-3-6 Blade 5-3-11
5-3-7 Travel 5-3-13
5-3-8 Non-Deviation Travel (with Boom, Arm or Boom Swing Operation) 5-3-15
5-3-9 Non-Deviation Travel (with Bucket Operation) 5-3-17
5-3-10 Simultaneous Operation of Boom Up and Arm Retract 5-3-19
5-3-11 Simultaneous Operation of Boom Up and Bucket 5-3-21
5-3-12 Simultaneous Operation of Boom Up and Swing 5-3-23
5-3-13 Simultaneous Operation of Arm and Bucket 5-3-25
5-3-14 Hydraulic P.T.O. 5-3-27
5-3-15 Quick Coupler 5-3-29
5-4 Pressure Adjustment 5-4-1
5-4-1 Relief Valves 5-4-1
5-4-2 Swing Brake Valve 5-4-4
5-4-3 Cut-Off Valve 5-4-5

CHAPTER 6
Hydraulic Equipment

6-1 Hydraulic Pump 6-1-1
6-2 Control Valve 6-2-1
6-3 Pilot Valve 6-3-1
6-4 Swing Motor 6-4-1
6-5 Travel Motor 6-5-1
6-6 Blade Control Pilot Valve 6-6-1
6-7 Solenoid Valve for P.T.O. Operation 6-7-1
6-8 Pilot Check Valve (For Quick Coupler Circuit) 6-8-1

CHAPTER 7
Adjustment and Repair

7-1 Electric Equipment of Machine 7-1-1
7-1-1 Parts Layout of Electrical Equipment 7-1-1
7-1-2 Monitor and Alarm Systems 7-1-4
7-1-3 Wiring Diagram 7-1-7
7-1-4 Circuit Description of Engine Start and Stop, and Battery Charging 7-1-9
7-1-5 Removal and Reinstallation of Engine 7-1-11
7-1-6 Removal and Reassembly of Starter Motor 7-1-20
7-1-7 Removal and Reassembly of Drive Belts for Generator and Compressor 7-1-21
7-2 Undercarriage 7-2-1
7-2-1 Outline 7-2-1
7-2-2 Main Parts 7-2-1
7-2-3 Points of Reassembly (Rubber Track) 7-2-2
7-2-4 Points of Reassembly (Steel Track) 7-2-3
7-2-5 Removal and Reinstallation of Track 7-2-4
7-2-6 Removal and Reinstallation of Steel Track 7-2-5
7-2-7 Disassembly and Reassembly of Front Idler 7-2-8
7-2-8 Disassembly and Reassembly of Track Roller 7-2-10
7-2-9 Installation of Floating Seal 7-2-12
7-2-10 Drawings of Jigs 7-2-13
7-2-11 Disassembly and Reassembly of Carrier Roller 7-2-15
7-3 Controls 7-3-1
7-3-1 Control Train 7-3-1
7-3-2 Mechanical Control Linkage 7-3-2
7-3-3 Adjustment of Travel Levers 7-3-4
7-3-4 Adjustment of Boom Swing Pedal 7-3-5
7-3-5 Adjustment of Lock Lever 7-3-6
7-3-6 Adjustment of Accelerator Lever 7-3-7
7-4 Swing Bearing 7-4-1
7-5 Hydraulic Equipment 7-5-1
7-5-1 Removal and Reinstallation of Hydraulic Pump 7-5-1
7-5-2 Removal and Reinstallation of Control Valve 7-5-3
7-5-3 Removal and Reinstallation of Swing Motor 7-5-6
7-5-4 Removal and Reinstallation of Swivel Joint 7-5-9
7-5-5 Disassembly and Reassembly of Swivel Joint 7-5-13
7-5-6 Disassembly and Reassembly of Hydraulic Cylinders 7-5-16
7-5-7 Hydraulic Oil Tank 7-5-20
7-5-8 Piping Layout 7-5-26
7-6 Work Implements 7-6-1
7-6-1 Removal and Reinstallation of Work Implements 7-6-1
7-6-2 Quick Coupler 7-6-10
7-7 Cabin 7-7-1
7-7-1 Cabin 7-7-1

CHAPTER 8
Periodic Inspection and Servicing

8-1 List of Periodic Inspection and Servicing 8-1-1

CHAPTER 9
Fuel, Lube Oil and Grease Recommended

9. Fuel, Lube Oil and Grease Recommended 9-1

CHAPTER 10
Troubleshooting

10-1 Non-breakdowns 10-1-1
10-1-1 Natural Release of Bucket 10-1-1
10-1-2 Discontinuous Arm Movement 10-1-1
10-1-3 Drifting of Upperstructure on Quick Travel Operation 10-1-2
10-1-4 Thermal Shock of Travel Motor 10-1-3
10-1-5 Elongation of Boom Swing Cylinder on 70 degrees Swing 10-1-4
10-1-6 Telescopic Motion of Boom Swing Cylinder with Lock Lever Set to Lock Position 10-1-5
10-1-7 Time Lag on Travel Speed Switching 10-1-6
10-1-8 Fluctuation in Oil Level of Hydraulic Oil Tank Due to Temperature Change 10-1-7
10-1-9 Operation of Quick Coupler Cylinder (for Quick Coupler Type) 10-1-8
10-2 Troubleshooting 10-2-1
10-2-1 Machine and Engine 10-2-1
10-2-2 Electrical Equipment on Panel 10-2-23

CHAPTER 11
Reference Data

11-1 Dimensions and Specifications for Attachment 11-1-1

CHAPTER 1

GENERAL CAUTIONS FOR MAINTENANCE WORK

1-1 Correct Work....1-1
1-2 Safety Precautions....1-1
1-3 Preparations....1-1
1-4 Cautions for Disassembly and Reassembly....1-1
1-5 Cautions for Removal and Installation of Hydraulic Equipment....1-2
1-6 Cautions for Removal and Installation of Hydraulic Piping....1-2
1-7 Cautions for Handling Seals....1-3
1-8 Correct Installation of Hydraulic Hose....1-3
1-9 Specifications of Hydraulic Hose....1-6
1-10 Air Release of Hydraulic Equipment....1-11

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1. General Cautions for Maintenance Work

1-1 Correct Work

Correct work means the quickest possible completion of according to the correct procedures and the specified standards.

It is important when conducting certain operations always to bear in mind the equipment, tools, gauges, materials, oil and grease, etc. that you must have ready, as well as items to be checked, adjusted, or disassembled, and cautions to watch out for.

1-2 Safety Precautions

(1) Never attempt servicing while engine is running or immediately after stopping operation.
(2) Wear work cloths, safety shoes and helmet.
(3) Check the equipment and tools before use. Especially, be sure to check the crane, lifting equipment and tools.
(4) When working together with other persons, allocate everyone's share of job, arrange the signals and act in concert with the other persons.
(5) The operation of the crane and slinging work must be performed by qualified persons.
(6) Do not enter or pass under the raised load.
(7) Lift and support the massive parts by crane before removing the installation bolts.
(8) Disconnect cables from battery before repairing the electric system.
(9) Remove the battery when welding the machine.

1-3 Preparations

(1) Check the service record of the machine. (That is, check how many months or hours the machine has been used since the preceding overhaul, what was the trouble then and what parts were replaced.)
(2) Have all servicing tools ready, i.e., tools, measuring devices (which have received periodic maintenance), containers, oil & grease, etc.
(3) Have the service literature (operation manual, parts catalog, etc.) ready.

1-4 Cautions for Disassembly and Reassembly

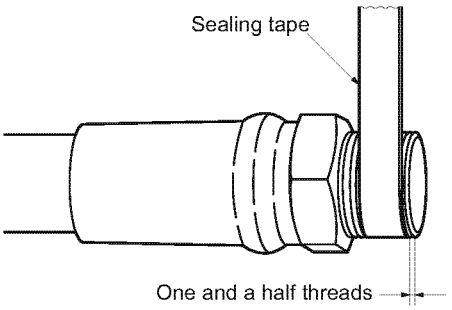
(1) Clean the machine before disassembly.
(2) Check and record the condition of the machine before disassembly :
  • Model, machine number, operation hours
  • Reasons for repair, history of repair
  • Contamination of filters
  • Fuel and oil condition
  • Damage to parts, etc.
(3) Place alignment marks on the necessary parts to facilitate reassembly.
(4) Clean all the removed parts and new replacement parts and put them in order.
(5) Use new seals, split pins, etc. for reassembly.

(6) Keep the parts apt to be damaged by water or oil apart from the oily or wet parts.
e.g.: Electrical parts, rubber parts, V-belts, etc.

(7) Use the jig for press-fitting the bearings, bushes and oil seals. When using a hammer, use a pad block.

(8) Clean the joint surface of all parts and keep them free from dust.

(9) Wind the sealing tape securely, leaving a space of one or two threads from the tip of the male screw. The tape should have an overlap of about 10 mm.



1-5 Cautions for Removal and Installation of Hydraulic Equipment

(1) Check that the hydraulic oil temperature is low enough.

(2) Release air from the hydraulic tank to prevent the hydraulic oil from flowing out.

(3) Be sure to plug open the ends of hydraulic components to prevent dust from entering.

(4) Be sure to wipe hydraulic oil from the hydraulic components so that it will not be mistaken for an oil leak.

(5) Take care not to damage the plating on the cylinder rod.

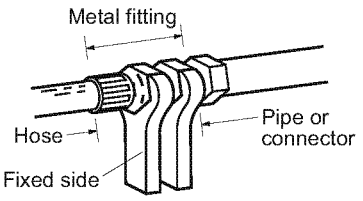
(6) Remove or install cylinders with rods fully retracted.

(7) Be sure to release air after installing the hydraulic cylinders.
- Run the engine at a low speed. Extend and retract the cylinders 4 to 5 times up to 50 to 100 mm from the end of the stroke. Then, fully extend and retract.

(8) Be sure to pressurize the hydraulic tank after installing the hydraulic components (in the case of the sealed hydraulic tank). Otherwise, hydraulic pumps might suffer cavitation and their life will be shortened.
- To pressurize the hydraulic tank, fully extend each cylinder and tighten the oil filter port plugs.

1-6 Cautions for Removal and Installation of Hydraulic Piping

(1) Installation of hydraulic hose
Take care not to twist the hoses. (Judge whether or not the hose is twisted by the hose mark.) For hoses with a metal fitting, use two wrenches to prevent twisting.
Use one to fix the hose, and the other to tighten the fitting to the specified tightening torque. Carefully check that the hoses do not come in contact after tightening. If any contact is found, correct it or use tubes.



(2) When installing hoses, first tighten to the specified torque and then loosen them a little. Then retighten to the specified torque.
- Break in the installed parts before tightening (except those using seal tapes).

(3) When installing pipes, turn the nuts more 1/4 to 1/2 turn after they reach the sharp torque rise point.

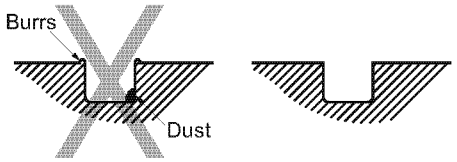
(4) When installing or removing hoses, use two wrenches, one to fasten the hose and the other to tighten or loosen the hose to prevent twisting.

(5) Check for oil leakage by applying max. pressure 5 to 6 times after attaching hydraulic hoses or pipes.

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

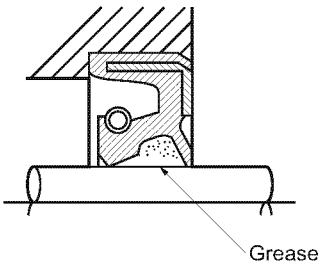
1-7 Cautions for Handling Seals

(1) Clean out grooves of O-rings. Remove burrs or dust if any.



(2) Take care not to twist O-rings. Correct by your finger if it is twisted.
(3) Take care not to damage seals when inserting.
(4) Handling of floating seals :
- Completely wipe off all the oil from the O-ring and housing after detaching the floating seals.
- Before installing, apply a little gear oil to the matching face of the housing.
- Turn the seals two or three times after installation to break them in.

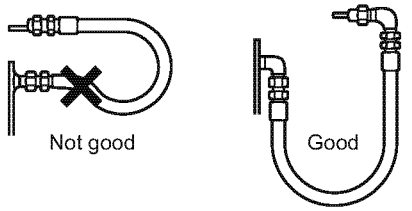
(5) Apply grease to the lip of the oil seals to prevent wear.



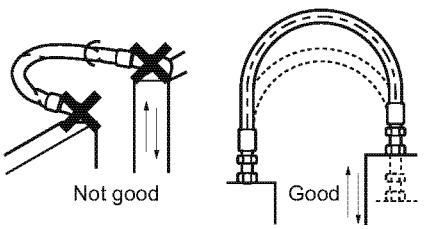
1-8 Correct Installation of Hydraulic Hose

In order to mount the hydraulic hose most effectively and economically, observe the following cautions.

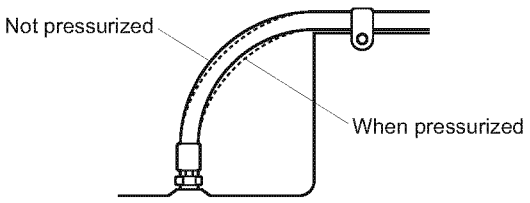
(1) When a hose is used at the minimum bending radius, use elbows to avoid sharp bending.



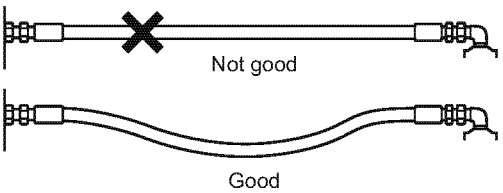
(2) To prevent twisting, the hose should be bent in the same direction as it moves.



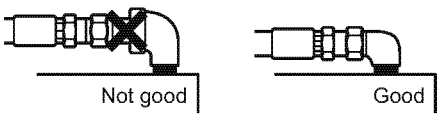
(3) When the hose is pressurized, the hose length varies slightly at the bend. Allow this change to occur and do not try to fasten the bend.



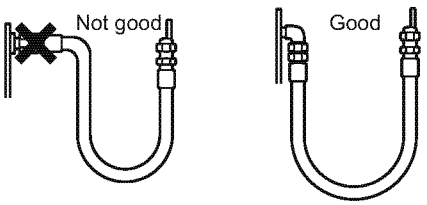
(4) It is necessary for the hose to have ample slackness for elongation and contraction, because its length will change by +2 % to -4 % when used at high pressure.



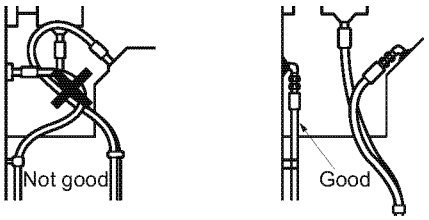
(5) Use the proper adapters, not pipes, in order to reduce the number and length of joints and improve the external appearance.



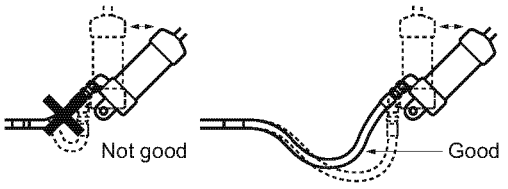
(6) Use an elbow to prevent excessive twisting or bending of the hose.



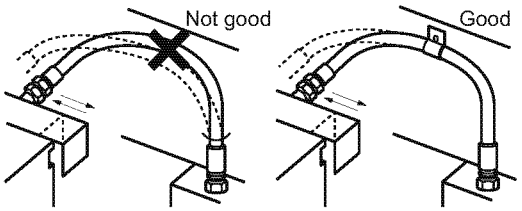
(7) Use adapters to make the hose as straight as possible. The outside appearance can be improved by avoiding the use of hoses that are too long.



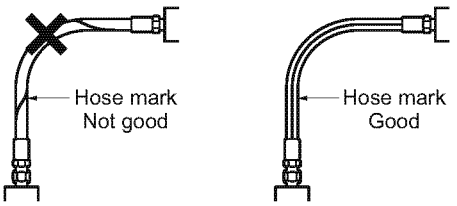
(8) The hose should be slightly longer than is absolutely necessary. The extra allows smoother movement of the hose and prevents sharp bending.



(9) When a bent hose is attached to two different planes, fix as shown in the diagram to prevent twisting.



(10) Use the marking on the hose as a guide to prevent twisting during installation.
Twisting of metal fitting with union nuts should be with a wrench on the hexagonal parts.

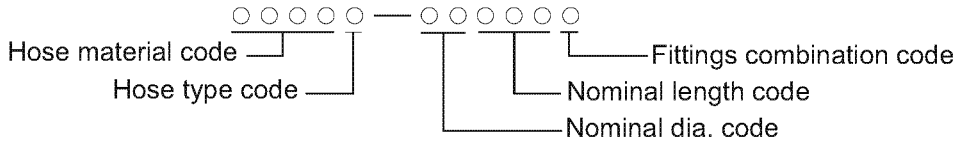


1-9 Specifications of Hydraulic Hose

Two types of hydraulic hoses are used in Yanmar Construction Machinery : the standard parts specified in the Yanmar Industrial Standards (YIS) and special parts for the respective models. Specifications of the hydraulic hoses can be known by the code number or part descriptions as explained below. (For the parts number, please refer to our Parts Catalog.)

(1) Yanmar Standard Type

The part code consists of 11-digit numbers :



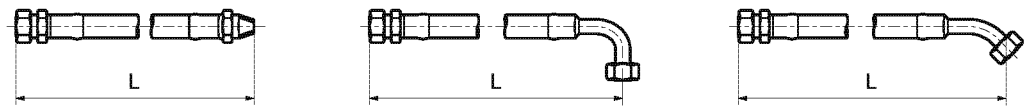
Description / Part code No. / Hose material	Hose material	Type of hose		Hose dia.	Hose length	Combination of fittings
	○○○○	○		○○	○○○	○
Rubber hose (High pressure type)	2320	1	(SAE J517,100R1)	02	Unit : cm	1
						3
				03		4
		2	(SAE J517,100R2)			5
				04		6
Plastic hose (High pressure type)	2327	1	(SAE J517,100R7)	02	↑	1
				03		4
				04		5
		2	(SAE J517,100R7)	03		7
				04		
Rubber hose (Medium pressure type)	2325	1	(SAE J517,100R6)	02	↑	1
				03		
				04		4
				05		
				06		
				10		5
				12		
				14		

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1) Type of Hose (Hose Dia. & Recommended Working Pressure)

Type of hose	Hose dia.	Inner dia. [in. (mm)]	Outer dia. [in. (mm)]	Working pressure [PSI (MPa)]
1 (SAE J517, 100R1)	02	0.25 (6.3)	0.53 (13.5)	2489 (17.2)
	03	0.37 (9.5)	0.69 (17.5)	1991 (13.7)
	04	0.50 (12.7)	0.81 (20.6)	1564 (10.8)
2 (SAE J517,100R7)	02	0.25 (6.3)	0.59 (15.1)	4266 (29.4)
	03	0.37 (9.5)	0.75 (19.1)	3484 (24.0)
	04	0.50 (12.7)	0.87 (22.2)	2986 (20.6)
1 (SAE J517, 100R6)	02	0.25 (6.3)	0.49 (12.5)	2986 (20.6)
	03	0.37 (9.5)	0.65 (16.6)	2489 (17.2)
	04	0.50 (12.7)	0.81 (20.7)	1991 (13.7)
2 (SAE J517,100R7)	03	0.37 (9.5)	0.68 (17.2)	2986 (20.6)
	04	0.50 (12.7)	0.84 (21.4)	2986 (20.6)
1 (SAE J517,100R6)	02	0.25 (6.3)	0.50 (12.7)	427 (2.9)
	03	0.37 (9.5)	0.63 (15.9)	427 (2.9)
	04	0.50 (12.7)	0.78 (19.8)	427 (2.9)
	05	0.63 (15.9)	0.91 (23.0)	427 (2.9)
	06	0.75 (19.0)	1.25 (31.8)	427 (2.9)
	10	1.00 (25.4)	1.50 (38.1)	427 (2.9)
	12	1.25 (31.8)	1.75 (44.5)	427 (2.9)
	14	1.50 (38.1)	2.04 (51.9)	427 (2.9)

2) Total Length of Hose [Unit : in. (cm)]



3 digit indication in cm. ***(Example)*** **Nominal length 065 : Full length 25.6 in. (65 cm)**

3) Hose Dia. (Unit : inch)

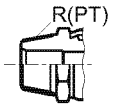
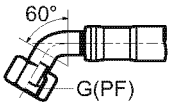
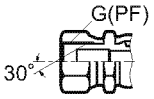
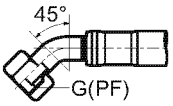
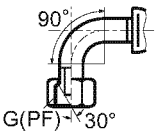
02....1/4"	05....5/8"	12....1 1/4"
03....3/8"	06....3/4"	14....1 1/2"
04....1/2"	10....1	

Note :

Please note that these code numbers are different from those for the equivalent diameters for special parts on the next page.

4) Combination of Fitting

Code No.	Fitting type
1	A·B
3	A·E
4	B·B
5	B·C
6	B·E
7	B·D

A		Taper pipe thread R (PT)	D		60 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat
B		Straight pipe thread G (PF) with male 30 degrees seat	E		45 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat
C		90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat			

(Example) Part code 2 3 2 0 2 – 0 3 0 8 5 5

- Rubber hose, high pressure type
- SAE J517, 100R2
- Nominal dia., 3 / 8"
- Hose length, 33.5 in. (85 cm)
- Straight pipe thread G (PF) with male 30 degrees seat and 90 degrees bent type.
- Straight pipe thread G (PF) with male 30 degrees seat

List of pipe threads	
Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Male taper pipe thread
Rc (PT)	Female taper pipe thread

Note :

All the hoses with fittings other than those listed above are special parts.

(2) Special Parts

Description ..... Hose P 2 06 AB 075 W —
1 2 3 4 5 6 7 8

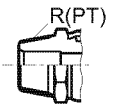
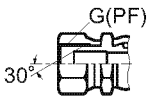
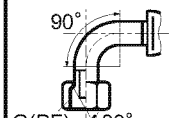
1 Part name

2 Hose material
- Rubber hose ..... G
- Wear-resistant high pressure rubber hose ..... H
- Plastic hose ..... P
- Wear-resistant plastic hose..... F

3 Recommended working pressure PSI(Mpa)
- Over 2986 (20.6) 1
- 2489 to 2986 (17.2 to 20.6) 2
- 1991 to 2489 (13.7 to 17.2) 3
- 1564 to 1991 (10.8 to 13.7) 4
- 995 to 1564 (6.9 to 10.8) 5
- 427 to 995 (2.9 to 6.9) 6
- 213 to 427 (1.5 to 2.9) 7
- Below 213 (1.5) 8

4 Nominal dia. (inch)
- 1 / 8" 02
- 3 / 16" 03
- 1 / 4" 04
- 3 / 8" 06
- 1 / 2" 08
- 5 / 8" 10
- 3 / 4" 12
- 1" 16

5 Combination of fitting

Fitting type	Code
 Taper pipe thread R (PT)	A
 Straight pipe thread G (PF) with male 30 degrees seat	B
 90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	C
Without fitting	Y

* For the combination of fitting, refer to the list on the following page.

6 Total length (Unit : cm)

7 Hose protector
- Coil spring ..... W
- Coil tube ..... S
- Wire braid ..... B
- Tube (Rubber) ..... R
- Tube (Vinyl) V
- Sponge rubber ..... P
- Hose cover ..... K
- No protection ..... Blank

8 Other accessories
- No accessories...Blank
- O-ring 1

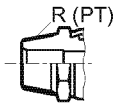
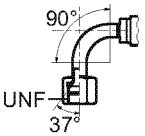
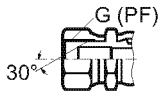
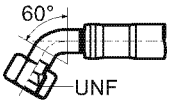
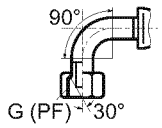
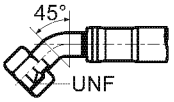
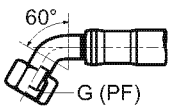
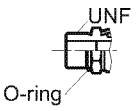
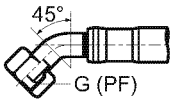
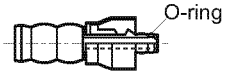
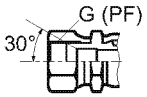
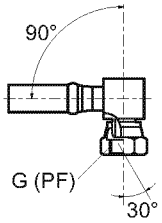
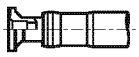
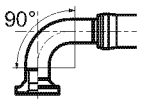
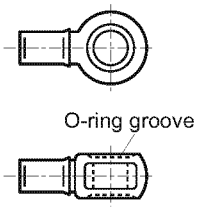
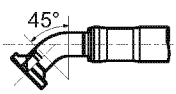
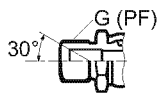
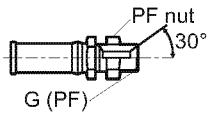
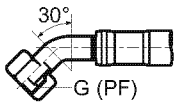
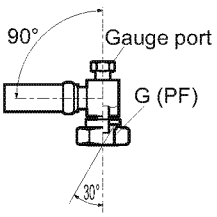
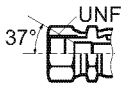
List of pipe threads

Symbol	Name
G (PF)	Straight pipe thread
R (PT)	Male taper pipe thread
Rc (PT)	Female taper pipe thread

The example hose, P 2 06 AB 075 W stands for :
2 3 4 5 6 7

2 Material : Plastic
3 Working pressure : 2489 to 2986 PSI (17.2 to 20.6 MPa)
4 Nominal dia. : 3 / 8"
5 Fitting type : Taper pipe thread R (PT) and straight pipe thread G (PF) with male 30 degrees seat.
6 Length : 29.5 in. (75 cm)
7 Hose protector : Coil spring

5 Combination of fitting

Fitting type		Code	Fitting type		Code
	Taper pipe thread R (PT)	A		90 degrees bent type. UNF thread with female 37 degrees seat	P
	Straight pipe thread G (PF) with male 30 degrees seat	B		60 degrees bent type. UNF thread with female 37 degrees seat	Q
	90 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	C		45 degrees bent type. UNF thread with female 37 degrees seat	R
	60 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	D		UNF, thread with O-ring groove	S
	45 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	E		One-touch fitting (male)	T
	Straight pipe thread G (PF) with male 30 degrees seat	F		90 degrees elbow straight pipe thread male 30 degrees seat	V
	O-ring flange type	G			
	90 degrees bent O-ring flange type	H		Eyejoint with O-ring groove	W
	45 degrees bent O-ring flange type	J			
	Straight pipe thread, female 30 degrees seat with O-ring groove	K		Straight pipe thread with jam nut female 30 degrees seat	X
	30 degrees bent type. Straight pipe thread G (PF) with male 30 degrees seat	L		90 degrees elbow straight pipe thread with gauge port plug male 30 degrees seat	Z
	Taper pipe thread NPTF	M			
	UNF, thread with female 37 degrees seat	N	Without fitting		Y

Note :

According to the combination of bending or elbow fittings, some hoses require drawings or original hoses to locally manufacture.

1-10 Air Release of Hydraulic Equipment

When operating the machine after disassembly or parts replacement of the hydraulic equipment, piping, etc., be sure to release air from the hydraulic system. This is necessary to prevent seizure and cavitation of the hydraulic equipment. If the air is left in the hydraulic system, the air is compressed or expanded depending on the load, having an adverse effect on the smooth operation of the hydraulic equipment and shortening the service life.

1. Air Release of Variable Displacement Piston Pumps

1) Put a Specified Quantity of Hydraulic Oil Into the Hydraulic Oil Tank.

Note :

1. Set the machine at the oil level check position.

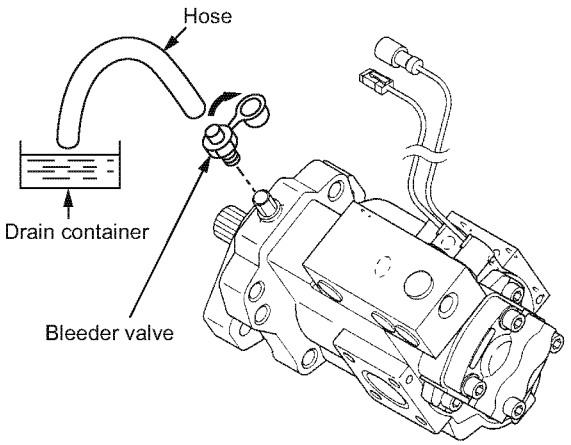
2. Refer to the hydraulic oil supply procedure for how to put hydraulic oil into the tank.

2) Keep the Oil Supply Cap of the Hydraulic Oil Tank Removed.

3) Install the Air Bleeder Hose onto the Bleeder Valve and Loosen the Bleeder Valve Half a Turn. (Inside Diameter of the Hose : 0.20 in. [5 mm])

Note :

Since the top end of the bleeder valve is acting as a seat surface, the air is released only by loosening the bleeder valve.



4) Check that All the Air has been Released from the Bleeder Valve.

5) Tighten the Bleeder Valve, Remove the Hose and Install the Cap on the Bleeder Valve.

Bleeder valve	Width across flats : 0.40 in. (10 mm)
Tightening torque	3.61 to 5.06 ft·lbf (4.9 to 6.7 N·m)

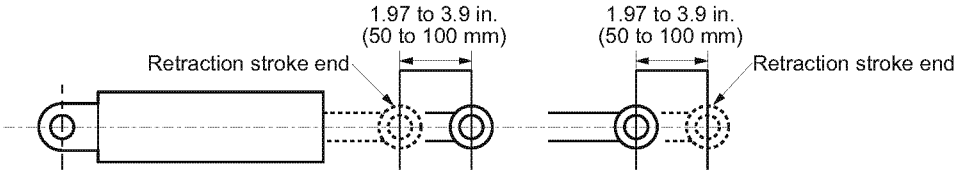
2. Air Release of Each Hydraulic Component

Run the engine at medium speed and activate the respective circuits for about 10 to 15 minutes.

3. Air Release of Hydraulic Cylinders

1) Set the Engine Speed at Low Idling Range.

2) Extend and Retract the Cylinder Up to 1.97 to 3.9 in. (50 to 100 mm) from Each Stroke End Slowly 4 or 5 Times.



Note :

The extension and retraction stroke is up to 1.97 in. (50 mm) from each stroke end for the blade cylinder.

3) Then, Fully Extend and Retract the Cylinder 3 or 4 Times.

CHAPTER 2

TECHNICAL DATA

2-1 Specifications 2-1-1
2-2 Outline Drawing and Working Area 2-2-1
2-2-1 Canopy type 2-2-1
2-2-2 Cabin type 2-2-2
2-3 Weight List of Main Parts 2-3-1
2-4 Lifting Capacity List 2-4-1

2. TECHNICAL DATA

2. Technical Data

2-1 Specifications

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5
Main specifications of machine					
Dimensions					
Overall length (Transportation position)				in. (mm)	207.1 (5260) <202.8 (5150)>
Cabin	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	77.6 (1970)
Canopy	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	77.6 (1970)
Tumbler center distance (steel/rubber)				in. (mm)	80.7 (2050)/81.5 (2070)
Track gauge				in. (mm)	65.7 (1670)
Minimum ground clearance				in. (mm)	14.2 (360)
Traveling performance					
Travel speed	Steel track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.9 (4.6)
	Rubber track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.9 (4.6)
Permissible water depth limit				in. (mm)	19.7 (500)
Work performance					
Bucket	Width (Standard) *including side cutter			in. (mm)	25.6 (650)
	(Standard. JIS heaped capacity)			cu.ft. (cu.m)	4.94 (0.14) [Old JIS 4.59 (0.13)]
	Number of teeth / Installation method			pcs.	4 / rubber pin lock type
Maximum digging depth	With blade raised			in. (mm)	144.9 (3680) <137.8 (3500)>
	With blade on the ground			in. (mm)	151.6 (3850) <145.7 (3700)>
Maximum depth of vertically digging				in. (mm)	106.3 (2700) <112.2 (2850)>
Maximum dumping height (canopy/cabin)				in. (mm)	153.9 (3910) <157.5 (4000)>
Minimum front swing radius (with boom in front) (canopy/cabin)				in. (mm)	91.3 (2320) <81.1 (2060)>
Minimum front swing radius (at 90 degrees right boom swing)			Cabin	in. (mm)	78.3 (1990) <68.1 (1730)>
			Canopy	in. (mm)	78.3 (1990) <68.1 (1730)>
Rear end swing radius				in. (mm)	38.4 (975)
Boom swing angle		Cabin	Left	degrees	70
			Right	degrees	70
		Canopy	Left	degrees	70
			Right	degrees	70
Maximum digging force		Bucket		lbs. (k•N)	6725 (29.9) <8489 (37.7)>
		Arm		lbs. (k•N)	4631 (20.6) <5292 (23.5)>

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5
Main specifications of machine					
Work performance					
Maximum tractive force (Oil pressure force) (steel/rubber)				lbs. (k•N)	9107 (40.5)/8655 (38.5)
Maximum swing inclination angle (with standard bucket)				degrees	18
Swing speed				rpm	10
Fuel consumption in practical operation				Gals/h (L/h)	1.48 (5.6)
Blade					
Blade	Width×Height			in. (mm)	77.6 (1970)×15.7 (400)
	Capacity			cu.ft. (cu.m)	10.9 (0.31)
	Lift above ground level			in. (mm)	19.7 (500) <17.3 (440)>
	Digging depth			in. (mm)	20.5 (520) <16.9 (430)>
Mean contact pressure					
JIS	Steel track	Cabin		PSI (KPa)	4.05 (27.9) <3.99 (27.5)>
		Canopy		PSI (KPa)	3.87 (26.7) <3.86 (26.6)>
	Rubber track	Cabin		PSI (KPa)	3.99 (27.5) <3.93 (27.1)>
		Canopy		PSI (KPa)	3.84 (26.5) <3.78 (26.1)>
Mass					
Operating mass	Steel track	Cabin		lbs. (kg)	9371 (4250) <9746 (4420)>
		Canopy		lbs. (kg)	8974 (4070) <9393 (4260)>
	Rubber track	Cabin		lbs. (kg)	9217 (4180) <9592 (4350)>
		Canopy		lbs. (kg)	8820 (4000) <9239 (4190)>
Base machine dry mass	Steel track	Cabin		lbs. (kg)	6461 (2930) <6461 (2930)>
		Canopy		lbs. (kg)	6064 (2750) <6064 (2750)>
	Rubber track	Cabin		lbs. (kg)	6304 (2860) <6304 (2860)>
		Canopy		lbs. (kg)	5909 (2680) <5909 (2680)>
Hydraulic equipment					
Hydraulic pump					
Drive method					Engine → CF Coupling → Pump (Direct drive)
Type of main pump					Variable displacement piston pumps + Gear pumps
Number of pumps					Piston pump : 2 + Gear pump : 2
Theoretical discharge volume				cu.in./rev (cu.cm/rev)	1.02 (16.8)×2, 1.02 (16.8), 0.30 (4.9)
Maximum allowable pressure				PSI (MPa)	3128 (21.6)×2, 3128 (21.6)×1, 427 (2.9)×1
Control valve					
Number of connected valves				pcs.	11
System relief set pressure	P1, P2			PSI (MPa)	3128 (21.6)
	P3			PSI (MPa)	3128 (21.6)
Circuit relief set pressure	Boom (at rod end)			PSI (MPa)	3555 (24.5)
	Boom (at bottom end)			PSI (MPa)	3555 (24.5)
	Arm (at rod end)			PSI (MPa)	3555 (24.5)
	Arm (at bottom end)			PSI (MPa)	3555 (24.5)

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5
Hydraulic equipment					
Control valve					
	Circuit relief set pressure		Bucket (at rod end)	PSI (MPa)	3555 (24.5)
			Bucket (at bottom end)	PSI (MPa)	3555 (24.5)
			Boom swing (at rod end)	PSI (MPa)	3555 (24.5)
			Boom swing (at bottom end)	PSI (MPa)	3555 (24.5)
			Blade (at rod end)	PSI (MPa)	2133 (14.7)
			Blade (at bottom end)	PSI (MPa)	-
Cylinder					
	Boom	Stroke		in. (mm)	26.0 (660)
		Inside diameter		in. (mm)	✱1 : Ø3.74 (Ø95), ✱2 : Ø3.94 (Ø100)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	✱1 : 2.2, ✱2 : 2.4
			Down (Max. → Ground)	sec.	✱1 : 2.5, ✱2 : 2.9
	Arm	Stroke		in. (mm)	29.9 (760)
		Inside diameter		in. (mm)	Ø3.3 (Ø85)
		Piston rod diameter		in. (mm)	Ø2.0 (Ø50)
		Speed	Full stroke for digging	sec.	2.5
			Full stroke for dumping	sec.	3.4
	Bucket	Stroke		in. (mm)	24.8 (630)
		Inside diameter		in. (mm)	Ø2.95 (Ø75)
		Piston rod diameter		in. (mm)	Ø1.95 (Ø50)
		Speed	Full stroke for digging	sec.	4.0
			Full stroke for dumping	sec.	2.4
	Blade	Stroke		in. (mm)	8.66 (220)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	0.9
			Down (Max. → Ground)	sec.	1.1
	Boom swing	Stroke		in. (mm)	21.8 (553)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.77 (Ø45)
		Speed	Full stroke to the right	sec.	6.5
			Full stroke to the left	sec.	6.5
	Quick coupler	Stroke		in. (mm)	3.39 (86)
		Inside diameter		in. (mm)	Ø2.56 (Ø65)
		Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
Swivel joint					
	Swivel joint port diameter×Number			inch×pcs.	3/8×4, 1/4×6

✱1 : S/N 50501 to 50591, ✱2 : S/N 50592 and after

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5
Hydraulic equipment					
Motor					
	Swing motor	Type			Fixed displacement piston motor
		Displacement		cu.in./rev (cu.cm/rev)	23.9 (391)
		Brake valve	Type		Cross relief valve
			Relief set pressure	PSI (MPa)	3128 (21.6)
	Travel motor	Type			Variable displacement piston motor
		Displacement (Low/High)		cu.in./rev (cu.cm/rev)	1.89 (31)/0.95 (15.5)
		Brake valve	Type		Counter balance valve
			Relief set pressure	PSI (MPa)	-
		Type of reduction gear			Planetary gear (with double-reduction mechanism)
Hydraulic oil tank					
	Tank capacity			Gals (L)	16.9 (64) [tank : 10.0 (38), others : 6.9 (26)]
	Suction filter	Type			CT-12W
		Filtration area		sq.in. (sq.cm)	108 (697)
		Filtration accuracy		Meshes	150
	Return filter	Type			Y2502
		Filtration area		sq.in. (sq.cm)	706.8 (4560)
		Filtration accuracy		μ	10
		By-pass valve opening pressure		PSI (MPa)	21.3 (0.147)
Locking device					
	Lever lock				Oil pressure controlled
	Boom swing lock				Pedal guard
	Swing lock				Mechanical brake
Swing device					
	Swing bearing				Spur gear
	Power transmission				Swing motor → Reduction gear → Pinion → Internal gear
	Type of brake				Oil pressure controlled + Mechanical brake
	Brake mounting position				Swing motor
Undercarriage					
	Steel track	Shoe width		in. (mm)	13.8 (350)
		Grouser	Type		Triple grouser
			Height	in. (mm)	0.55 (14)
		Shoe and link mounting method			Bolt
		Link pitch		in. (mm)	5.31 (135)
		Number of shoes (One side)		pcs.	40
		Track drive method			Link driving

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5
Undercarriage				
	Rubber track	Shoe width	in. (mm)	13.8 (350)
		Lug height	in. (mm)	0.98 (25)
		Core metal pitch	in. (mm)	2.97 (75.5)
	Carrier roller (Upper roller)	Manner of support		Overhang type
		Quantity (One side)	pcs.	1
		Bearing		Bearing
		Sealing		Shaft seal
	Number of shoe slide plates (One side)		pcs.	-
	Track roller (Lower roller)	Quantity (One side)	pcs.	4
		Bearing		Bush
		Sealing		Floating seal
	Idler	Quantity (One side)	pcs.	1
		Bearing		Bush
		Sealing		Floating seal
	Number of sprocket teeth	Steel track	pcs.	19
		Rubber track	pcs.	19
	Track tension adjustment			Grease adjuster

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5B
Main specifications of machine					
Dimensions					
Overall length (Transportation position)				in. (mm)	207.1 (5260) <202.8 (5150)>
Cabin	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	77.6 (1970)
Canopy	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	77.6 (1970)
Tumbler center distance (steel/rubber)				in. (mm)	80.7 (2050)/81.5 (2070)
Track gauge				in. (mm)	65.7 (1670)
Minimum ground clearance				in. (mm)	14.2 (360)
Traveling performance					
Travel speed	Steel track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.9 (4.6)
	Rubber track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.9 (4.6)
Permissible water depth limit				in. (mm)	19.7 (500)
Work performance					
Bucket	Width (Standard) *including side cutter			in. (mm)	25.6 (650)
	(Standard. JIS heaped capacity)			cu.ft. (cu.m)	4.94 (0.14) [Old JIS 4.59 (0.13)]
	Number of teeth / Installation method			pcs.	4 / rubber pin lock type
Maximum digging depth	With blade raised			in. (mm)	144.9 (3680) <137.8 (3500)>
	With blade on the ground			in. (mm)	151.6 (3850) <145.7 (3700)>
Maximum depth of vertically digging				in. (mm)	106.3 (2700) <112.2 (2850)>
Maximum dumping height (canopy/cabin)				in. (mm)	153.9 (3910) <157.5 (4000)>
Minimum front swing radius (with boom in front) (canopy/cabin)				in. (mm)	91.3 (2320) <81.1 (2060)>
Minimum front swing radius (at 90 degrees right boom swing)			Cabin	in. (mm)	78.3 (1990) <68.1 (1730)>
			Canopy	in. (mm)	78.3 (1990) <68.1 (1730)>
Rear end swing radius				in. (mm)	38.4 (975)
Boom swing angle		Cabin	Left	degrees	70
			Right	degrees	70
		Canopy	Left	degrees	70
			Right	degrees	70
Maximum digging force		Bucket		lbs. (k•N)	6725 (29.9) <8489 (37.7)>
		Arm		lbs. (k•N)	4631 (20.6) <5292 (23.5)>

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5B
Main specifications of machine					
Work performance					
Maximum tractive force (Oil pressure force) (steel/rubber)				lbs. (k•N)	9107 (40.5)/8655 (38.5)
Maximum swing inclination angle (with standard bucket)				degrees	18
Swing speed				rpm	10
Fuel consumption in practical operation				Gals/h (L/h)	1.43 (5.4)
Blade					
Blade	Width×Height			in. (mm)	77.6 (1970)×15.7 (400)
	Capacity			cu.ft. (cu.m)	10.9 (0.31)
	Lift above ground level			in. (mm)	19.7 (500) <17.3 (440)>
	Digging depth			in. (mm)	20.5 (520) <16.9 (430)>
Mean contact pressure					
JIS	Steel track	Cabin		PSI (KPa)	4.12 (28.4) <4.22 (29.1)>
		Canopy		PSI (KPa)	3.95 (27.2) <4.05 (27.9)>
	Rubber track	Cabin		PSI (KPa)	4.02 (27.7) <4.12 (28.4)>
		Canopy		PSI (KPa)	3.86 (26.6) <3.95 (27.2)>
Mass					
Operating mass	Steel track	Cabin		lbs. (kg)	9965 (4520) <10207 (4630)>
		Canopy		lbs. (kg)	9546 (4330) <9789 (4440)>
	Rubber track	Cabin		lbs. (kg)	9833 (4460) <10075 (4570)>
		Canopy		lbs. (kg)	9414 (4270) <9656 (4380)>
Base machine dry mass	Steel track	Cabin		lbs. (kg)	7275 (3300) <7275 (3300)>
		Canopy		lbs. (kg)	6856 (3110) <6856 (3110)>
	Rubber track	Cabin		lbs. (kg)	7143 (3240) <7143 (3240)>
		Canopy		lbs. (kg)	6724 (3050) <6724 (3050)>
Hydraulic equipment					
Hydraulic pump					
Drive method					Engine → CF Coupling → Pump (Direct drive)
Type of main pump					Variable displacement piston pumps + Gear pumps
Number of pumps					Piston pump : 2 + Gear pump : 2
Theoretical discharge volume				cu.in./rev (cu.cm/rev)	1.02 (16.8)×2, 1.02 (16.8), 0.30 (4.9)
Maximum allowable pressure				PSI (MPa)	3128 (21.6)×2, 3128 (21.6)×1, 427 (2.9)×1
Control valve					
Number of connected valves				pcs.	11
System relief set pressure	P1, P2			PSI (MPa)	3128 (21.6)
	P3			PSI (MPa)	3128 (21.6)
Circuit relief set pressure	Boom (at rod end)			PSI (MPa)	3555 (24.5)
	Boom (at bottom end)			PSI (MPa)	3555 (24.5)
	Arm (at rod end)			PSI (MPa)	3555 (24.5)
	Arm (at bottom end)			PSI (MPa)	3555 (24.5)

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5B
Hydraulic equipment					
Control valve					
	Circuit relief set pressure		Bucket (at rod end)	PSI (MPa)	3555 (24.5)
			Bucket (at bottom end)	PSI (MPa)	3555 (24.5)
			Boom swing (at rod end)	PSI (MPa)	3555 (24.5)
			Boom swing (at bottom end)	PSI (MPa)	3555 (24.5)
			Blade (at rod end)	PSI (MPa)	2133 (14.7)
			Blade (at bottom end)	PSI (MPa)	-
Cylinder					
	Boom	Stroke		in. (mm)	26.0 (660)
		Inside diameter		in. (mm)	Ø3.94 (Ø100)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	2.4
			Down (Max. → Ground)	sec.	2.9
	Arm	Stroke		in. (mm)	29.9 (760)
		Inside diameter		in. (mm)	Ø3.3 (Ø85)
		Piston rod diameter		in. (mm)	Ø2.0 (Ø50)
		Speed	Full stroke for digging	sec.	2.5
			Full stroke for dumping	sec.	3.4
	Bucket	Stroke		in. (mm)	24.8 (630)
		Inside diameter		in. (mm)	Ø2.95 (Ø75)
		Piston rod diameter		in. (mm)	Ø1.95 (Ø50)
		Speed	Full stroke for digging	sec.	4.0
			Full stroke for dumping	sec.	2.4
	Blade	Stroke		in. (mm)	8.66 (220)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	0.9
			Down (Max. → Ground)	sec.	1.1
	Boom swing	Stroke		in. (mm)	21.8 (553)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.77 (Ø45)
		Speed	Full stroke to the right	sec.	6.5
			Full stroke to the left	sec.	6.5
	Quick coupler	Stroke		in. (mm)	3.39 (86)
		Inside diameter		in. (mm)	Ø2.56 (Ø65)
		Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
Swivel joint					
	Swivel joint port diameter×Number			inch×pcs.	3/8×4, 1/4×6

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5B
Hydraulic equipment					
Motor					
	Swing motor	Type			Fixed displacement piston motor
		Displacement		cu.in./rev (cu.cm/rev)	23.9 (391)
		Brake valve	Type		Cross relief valve
			Relief set pressure	PSI (MPa)	3128 (21.6)
	Travel motor	Type			Variable displacement piston motor
		Displacement (Low/High)		cu.in./rev (cu.cm/rev)	1.89 (31)/0.95 (15.5)
		Brake valve	Type		Counter balance valve
			Relief set pressure	PSI (MPa)	-
		Type of reduction gear			Planetary gear (with double-reduction mechanism)
Hydraulic oil tank					
	Tank capacity			Gals (L)	16.9 (64) [tank : 10.0 (38), others : 6.9 (26)]
	Suction filter	Type			CT-12W
		Filtration area		sq.in. (sq.cm)	108 (697)
		Filtration accuracy		Meshes	150
	Return filter	Type			Y2502
		Filtration area		sq.in. (sq.cm)	706.8 (4560)
		Filtration accuracy		μ	10
		By-pass valve opening pressure		PSI (MPa)	21.3 (0.147)
Locking device					
	Lever lock				Oil pressure controlled
	Boom swing lock				Pedal guard
	Swing lock				Mechanical brake
Swing device					
	Swing bearing				Spur gear
	Power transmission				Swing motor → Reduction gear → Pinion → Internal gear
	Type of brake				Oil pressure controlled + Mechanical brake
	Brake mounting position				Swing motor
Undercarriage					
	Steel track	Shoe width		in. (mm)	13.8 (350)
		Grouser	Type		Triple grouser
			Height	in. (mm)	0.55 (14)
		Shoe and link mounting method			Bolt
		Link pitch		in. (mm)	5.31 (135)
		Number of shoes (One side)		pcs.	40
		Track drive method			Link driving

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5B
Undercarriage				
	Rubber track	Shoe width	in. (mm)	13.8 (350)
		Lug height	in. (mm)	0.98 (25)
		Core metal pitch	in. (mm)	2.97 (75.5)
	Carrier roller (Upper roller)	Manner of support		Overhang type
		Quantity (One side)	pcs.	1
		Bearing		Bearing
		Sealing		Shaft seal
	Number of shoe slide plates (One side)		pcs.	-
	Track roller (Lower roller)	Quantity (One side)	pcs.	4
		Bearing		Bush
		Sealing		Floating seal
	Idler	Quantity (One side)	pcs.	1
		Bearing		Bush
		Sealing		Floating seal
	Number of sprocket teeth	Steel track	pcs.	19
		Rubber track	pcs.	19
	Track tension adjustment			Grease adjuster

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5
Main specifications of machine					
Dimensions					
Overall length (Transportation position)				in. (mm)	218.9 (5560) <216.1 (5560)>
Cabin	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	78.3 (1990)
Canopy	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	78.3 (1990)
Tumbler center distance (steel/rubber)				in. (mm)	80.7 (2050)/81.5 (2070)
Track gauge				in. (mm)	65.7 (1670)
Minimum ground clearance				in. (mm)	14.1 (360)
Traveling performance					
Travel speed	Steel track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.7 (4.4)
	Rubber track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.7 (4.4)
Permissible water depth limit				in. (mm)	19.7 (500)
Work performance					
Bucket	Width (Standard) *including side cutter			in. (mm)	27.6 (700)
	(Standard. JIS heaped capacity)			cu.ft. (cu.m)	5.65 (0.16) [Old JIS 4.94 (0.14)]
	Number of teeth / Installation method			pcs.	4 (rubber pin lock type)
Maximum digging depth	With blade raised			in. (mm)	156.7 (3980) <149.6 (3800)>
	With blade on the ground			in. (mm)	163.8 (4160) <156.7 (3980)>
Maximum depth of vertically digging				in. (mm)	114.2 (2900) <122.0 (3100)>
Maximum dumping height (canopy/cabin)				in. (mm)	173.2 (4400) <177.2 (4500)>
Minimum front swing radius (with boom in front) (canopy/cabin)				in. (mm)	91.3 (2320) <79.5 (2020)>
Minimum front swing radius (at 90 degrees right boom swing)			Cabin	in. (mm)	77.2 (1960) <65.4 (1660)>
			Canopy	in. (mm)	77.2 (1960) <65.4 (1660)>
Rear end swing radius				in. (mm)	39.2 (995)
Boom swing angle		Cabin	Left	degrees	70
			Right	degrees	70
		Canopy	Left	degrees	70
			Right	degrees	70
Maximum digging force		Bucket		lbs. (k•N)	7607 (33.8) <9592 (42.7)>
		Arm		lbs. (k•N)	5579 (24.8) <5292 (23.5)>

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5
Main specifications of machine					
Work performance					
Maximum tractive force (Oil pressure force) (steel/rubber)				lbs. (k•N)	10760 (47.9)/12039 (53.5)
Maximum swing inclination angle (with standard bucket)				degrees	18 (at loading)
Swing speed				rpm	10
Fuel consumption in practical operation				Gals/h (L/h)	1.48 (5.6)
Blade					
Blade	Width×Height			in. (mm)	77.6 (1970)×15.7 (400)
	Capacity			cu.ft. (cu.m)	10.9 (0.31)
	Lift above ground level			in. (mm)	19.7 (500) <17.3 (440)>
	Digging depth			in. (mm)	20.5 (520) <16.9 (430)>
Mean contact pressure					
JIS	Steel track	Cabin		PSI (KPa)	3.97 (27.4) <3.93 (27.1)>
		Canopy		PSI (KPa)	3.83 (26.4) <3.78 (26.1)>
	Rubber track	Cabin		PSI (KPa)	3.92 (27.0) <3.87 (26.7)>
		Canopy		PSI (KPa)	3.77 (26.0) <3.73 (25.7)>
Mass					
Operating mass	Steel track	Cabin		lbs. (kg)	11201 (5080) <11069 (5020)>
		Canopy		lbs. (kg)	10849 (4920) <10716 (4860)>
	Rubber track	Cabin		lbs. (kg)	11047 (5010) <10915 (4950)>
		Canopy		lbs. (kg)	10694 (4850) <10562 (4790)>
Base machine dry mass	Steel track	Cabin		lbs. (kg)	8379 (3800) <8379 (3800)>
		Canopy		lbs. (kg)	8026 (3640) <8026 (3640)>
	Rubber track	Cabin		lbs. (kg)	8225 (3730) <8225 (3730)>
		Canopy		lbs. (kg)	7872 (3570) <7872 (3570)>
Hydraulic equipment					
Hydraulic pump					
Drive method					Engine → CF Coupling → Pump (Direct drive)
Type of main pump					Variable displacement piston pumps + Gear pumps
Number of pumps					Piston pump : 2 + Gear pump : 2
Theoretical discharge volume				cu.in./rev (cu.cm/rev)	1.02 (16.8)×2, 1.02 (16.8), 0.30 (4.9)
Maximum allowable pressure				PSI (MPa)	3555 (24.5)×2, 3555 (24.5)×1, 427 (2.9)×1
Control valve					
Number of connected valves				pcs.	11
System relief set pressure	P1, P2			PSI (MPa)	3555 (24.5)
	P3			PSI (MPa)	3555 (24.5)
Circuit relief set pressure	Boom (at rod end)			PSI (MPa)	3982 (27.5)
	Boom (at bottom end)			PSI (MPa)	3982 (27.5)
	Arm (at rod end)			PSI (MPa)	3982 (27.5)
	Arm (at bottom end)			PSI (MPa)	3982 (27.5)

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5
Hydraulic equipment					
Control valve					
	Circuit relief set pressure		Bucket (at rod end)	PSI (MPa)	3982 (27.5)
			Bucket (at bottom end)	PSI (MPa)	3982 (27.5)
			Boom swing (at rod end)	PSI (MPa)	3982 (27.5)
			Boom swing (at bottom end)	PSI (MPa)	3982 (27.5)
			Blade (at rod end)	PSI (MPa)	2133 (14.7)
			Blade (at bottom end)	PSI (MPa)	-
Cylinder					
	Boom	Stroke		in. (mm)	26.0 (660)
		Inside diameter		in. (mm)	✱1 : Ø3.74 (Ø95), ✱2 : Ø3.94 (Ø100)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	✱1 : 2.2, ✱2 : 2.6
			Down (Max. → Ground)	sec.	✱1 : 2.5, ✱2 : 3.2
	Arm	Stroke		in. (mm)	29.9 (760)
		Inside diameter		in. (mm)	Ø3.35 (Ø85)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Full stroke for digging	sec.	2.5
			Full stroke for dumping	sec.	3.4
	Bucket	Stroke		in. (mm)	24.8 (630)
		Inside diameter		in. (mm)	Ø2.95 (Ø75)
		Piston rod diameter		in. (mm)	Ø1.95 (Ø50)
		Speed	Full stroke for digging	sec.	4.0
			Full stroke for dumping	sec.	2.4
	Blade	Stroke		in. (mm)	8.66 (220)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	1.0
			Down (Max. → Ground)	sec.	1.2
	Boom swing	Stroke		in. (mm)	21.8 (553)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.77 (Ø45)
		Speed	Full stroke to the right	sec.	6.5
			Full stroke to the left	sec.	6.5
	Quick coupler	Stroke		in. (mm)	3.39 (86)
		Inside diameter		in. (mm)	Ø2.56 (Ø65)
		Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
Swivel joint					
	Swivel joint port diameter×Number			inch×pcs.	3/8×4, 1/4×6

✱1 : S/N 50501 to 50800, ✱2 : S/N 50801 and after

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5
Hydraulic equipment					
Motor					
	Swing motor	Type			Fixed displacement piston motor
		Displacement		cu.in./rev (cu.cm/rev)	23.9 (391)
		Brake valve	Type		Cross relief valve
			Relief set pressure	PSI (MPa)	3128 (21.6)
	Travel motor	Type			Variable displacement piston motor
		Displacement (Low/High)		cu.in./rev (cu.cm/rev)	2.06 (33.8)/1.03 (16.9)
		Brake valve	Type		Counter balance valve
			Relief set pressure	PSI (MPa)	-
		Type of reduction gear			Planetary gear (with double-reduction mechanism)
Hydraulic oil tank					
	Tank capacity			Gals (L)	16.9 (64) [tank : 10.0 (38), others : 6.9 (26)]
	Suction filter	Type			CT-12W
		Filtration area		sq.in. (sq.cm)	108 (697)
		Filtration accuracy		Meshes	150
	Return filter	Type			Y2502
		Filtration area		sq.in. (sq.cm)	706.8 (4560)
		Filtration accuracy		μ	10
		By-pass valve opening pressure		PSI (MPa)	21.3 (0.147)
Locking device					
	Lever lock				Oil pressure controlled
	Boom swing lock				Pedal guard
	Swing lock				Mechanical brake
Swing device					
	Swing bearing				Spur gear
	Power transmission				Swing motor → Reduction gear → Pinion → Internal gear
	Type of brake				Oil pressure controlled + Mechanical brake
	Brake mounting position				Swing motor
Undercarriage					
	Steel track	Shoe width		in. (mm)	15.7 (400)
		Grouser	Type		Triple grouser
			Height	in. (mm)	0.55 (14)
		Shoe and link mounting method			Bolt
		Link pitch		in. (mm)	5.31 (135)
		Number of shoes (One side)		pcs.	40
		Track drive method			Link driving

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO55-5
Undercarriage				
	Rubber track	Shoe width	in. (mm)	15.7 (400)
		Lug height	in. (mm)	0.98 (25)
		Core metal pitch	in. (mm)	2.97 (75.5)
	Carrier roller (Upper roller)	Manner of support		Overhung type
		Quantity (One side)	pcs.	1
		Bearing		Bearing
		Sealing		Shaft seal
	Number of shoe slide plates (One side)		pcs.	-
	Track roller (Lower roller)	Quantity (One side)	pcs.	4
		Bearing		Bush
		Sealing		Floating seal
	Idler	Quantity (One side)	pcs.	1
		Bearing		Bush
		Sealing		Floating seal
	Number of sprocket teeth	Steel track	pcs.	19
		Rubber track	pcs.	19
	Track tension adjustment			Grease adjuster

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5B
Main specifications of machine					
Dimensions					
Overall length (Transportation position)				in. (mm)	218.9 (5560) <216.1 (5560)>
Cabin	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	78.3 (1990)
Canopy	Overall height	Transportation position		in. (mm)	103.1 (2620)
		Traveling position		in. (mm)	103.1 (2620)
	Overall width	Full machine width		in. (mm)	78.3 (1990)
Tumbler center distance (steel/rubber)				in. (mm)	80.7 (2050)/81.5 (2070)
Track gauge				in. (mm)	65.7 (1670)
Minimum ground clearance				in. (mm)	14.1 (360)
Traveling performance					
Travel speed	Steel track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.7 (4.4)
	Rubber track	Low speed (Forward/Reverse)		MPH (km/hr)	1.4 (2.3)
		High speed (Forward/Reverse)		MPH (km/hr)	2.7 (4.4)
Permissible water depth limit				in. (mm)	19.7 (500)
Work performance					
Bucket	Width (Standard) *including side cutter			in. (mm)	27.6 (700)
	(Standard. JIS heaped capacity)			cu.ft. (cu.m)	5.65 (0.16) [Old JIS 4.94 (0.14)]
	Number of teeth / Installation method			pcs.	4 (rubber pin lock type)
Maximum digging depth	With blade raised			in. (mm)	156.7 (3980) <149.6 (3800)>
	With blade on the ground			in. (mm)	163.8 (4160) <156.7 (3980)>
Maximum depth of vertically digging				in. (mm)	114.2 (2900) <122.0 (3100)>
Maximum dumping height (canopy/cabin)				in. (mm)	173.2 (4400) <177.2 (4500)>
Minimum front swing radius (with boom in front) (canopy/cabin)				in. (mm)	91.3 (2320) <79.5 (2020)>
Minimum front swing radius (at 90 degrees right boom swing)			Cabin	in. (mm)	77.2 (1960) <65.4 (1660)>
			Canopy	in. (mm)	77.2 (1960) <65.4 (1660)>
Rear end swing radius				in. (mm)	39.2 (995)
Boom swing angle		Cabin	Left	degrees	70
			Right	degrees	70
		Canopy	Left	degrees	70
			Right	degrees	70
Maximum digging force		Bucket		lbs. (k•N)	7607 (33.8) <9592 (42.7)>
		Arm		lbs. (k•N)	5579 (24.8) <5292 (23.5)>

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5B
Main specifications of machine					
Work performance					
Maximum tractive force (Oil pressure force) (steel/rubber)				lbs. (k•N)	10760 (47.9)/12039 (53.5)
Maximum swing inclination angle (with standard bucket)				degrees	18 (at loading)
Swing speed				rpm	10
Fuel consumption in practical operation				Gals/h (L/h)	1.48 (5.6)
Blade					
Blade	Width×Height			in. (mm)	77.6 (1970)×15.7 (400)
	Capacity			cu.ft. (cu.m)	10.9 (0.31)
	Lift above ground level			in. (mm)	19.7 (500) <17.3 (440)>
	Digging depth			in. (mm)	20.5 (520) <16.9 (430)>
Mean contact pressure					
JIS	Steel track	Cabin		PSI (KPa)	4.06 (28.0) <4.15 (28.6)>
		Canopy		PSI (KPa)	3.90 (26.9) <3.99 (27.5)>
	Rubber track	Cabin		PSI (KPa)	3.99 (27.5) <4.08 (28.1)>
		Canopy		PSI (KPa)	3.84 (26.5) <3.93 (27.1)>
Mass					
Operating mass	Steel track	Cabin		lbs. (kg)	11199 (5080) <11442 (5190)>
		Canopy		lbs. (kg)	10781 (4890) <11023 (5000)>
	Rubber track	Cabin		lbs. (kg)	11155 (5060) <11398 (5170)>
		Canopy		lbs. (kg)	10737 (4870) <10979 (4980)>
Base machine dry mass	Steel track	Cabin		lbs. (kg)	8422 (3820) <8422 (3820)>
		Canopy		lbs. (kg)	8003 (3630) <8003 (3630)>
	Rubber track	Cabin		lbs. (kg)	8378 (3800) <8378 (3800)>
		Canopy		lbs. (kg)	7959 (3610) <7959 (3610)>
Hydraulic equipment					
Hydraulic pump					
Drive method					Engine → CF Coupling → Pump (Direct drive)
Type of main pump					Variable displacement piston pumps + Gear pumps
Number of pumps					Piston pump : 2 + Gear pump : 2
Theoretical discharge volume				cu.in./rev (cu.cm/rev)	1.02 (16.8)×2, 1.02 (16.8), 0.30 (4.9)
Maximum allowable pressure				PSI (MPa)	3555 (24.5)×2, 3555 (24.5)×1, 427 (2.9)×1
Control valve					
Number of connected valves				pcs.	11
System relief set pressure	P1, P2			PSI (MPa)	3555 (24.5)
	P3			PSI (MPa)	3555 (24.5)
Circuit relief set pressure	Boom (at rod end)			PSI (MPa)	3982 (27.5)
	Boom (at bottom end)			PSI (MPa)	3982 (27.5)
	Arm (at rod end)			PSI (MPa)	3982 (27.5)
	Arm (at bottom end)			PSI (MPa)	3982 (27.5)

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5B
Hydraulic equipment					
Control valve					
	Circuit relief set pressure		Bucket (at rod end)	PSI (MPa)	3982 (27.5)
			Bucket (at bottom end)	PSI (MPa)	3982 (27.5)
			Boom swing (at rod end)	PSI (MPa)	3982 (27.5)
			Boom swing (at bottom end)	PSI (MPa)	3982 (27.5)
			Blade (at rod end)	PSI (MPa)	2133 (14.7)
			Blade (at bottom end)	PSI (MPa)	-
Cylinder					
	Boom	Stroke		in. (mm)	26.0 (660)
		Inside diameter		in. (mm)	Ø3.94 (Ø100)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	2.6
			Down (Max. → Ground)	sec.	3.2
	Arm	Stroke		in. (mm)	29.9 (760)
		Inside diameter		in. (mm)	Ø3.35 (Ø85)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Full stroke for digging	sec.	2.5
			Full stroke for dumping	sec.	3.4
	Bucket	Stroke		in. (mm)	24.8 (630)
		Inside diameter		in. (mm)	Ø2.95 (Ø75)
		Piston rod diameter		in. (mm)	Ø1.95 (Ø50)
		Speed	Full stroke for digging	sec.	4.0
			Full stroke for dumping	sec.	2.4
	Blade	Stroke		in. (mm)	8.66 (220)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.97 (Ø50)
		Speed	Up (Ground → Max.)	sec.	1.0
			Down (Max. → Ground)	sec.	1.2
	Boom swing	Stroke		in. (mm)	21.8 (553)
		Inside diameter		in. (mm)	Ø3.54 (Ø90)
		Piston rod diameter		in. (mm)	Ø1.77 (Ø45)
		Speed	Full stroke to the right	sec.	6.5
			Full stroke to the left	sec.	6.5
	Quick coupler	Stroke		in. (mm)	3.39 (86)
		Inside diameter		in. (mm)	Ø2.56 (Ø65)
		Piston rod diameter		in. (mm)	Ø1.38 (Ø35)
Swivel joint					
	Swivel joint port diameter×Number			inch×pcs.	3/8×4, 1/4×6

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO55-5B
Hydraulic equipment					
Motor					
	Swing motor	Type			Fixed displacement piston motor
		Displacement		cu.in./rev (cu.cm/rev)	23.9 (391)
		Brake valve	Type		Cross relief valve
			Relief set pressure	PSI (MPa)	3128 (21.6)
	Travel motor	Type			Variable displacement piston motor
		Displacement (Low/High)		cu.in./rev (cu.cm/rev)	2.06 (33.8)/1.03 (16.9)
		Brake valve	Type		Counter balance valve
			Relief set pressure	PSI (MPa)	-
		Type of reduction gear			Planetary gear (with double-reduction mechanism)
Hydraulic oil tank					
	Tank capacity			Gals (L)	16.9 (64) [tank : 10.0 (38), others : 6.9 (26)]
	Suction filter	Type			CT-12W
		Filtration area		sq.in. (sq.cm)	108 (697)
		Filtration accuracy		Meshes	150
	Return filter	Type			Y2502
		Filtration area		sq.in. (sq.cm)	706.8 (4560)
		Filtration accuracy		μ	10
		By-pass valve opening pressure		PSI (MPa)	21.3 (0.147)
Locking device					
	Lever lock				Oil pressure controlled
	Boom swing lock				Pedal guard
	Swing lock				Mechanical brake
Swing device					
	Swing bearing				Spur gear
	Power transmission				Swing motor → Reduction gear → Pinion → Internal gear
	Type of brake				Oil pressure controlled + Mechanical brake
	Brake mounting position				Swing motor
Undercarriage					
	Steel track	Shoe width		in. (mm)	15.7 (400)
		Grouser	Type		Triple grouser
			Height	in. (mm)	0.55 (14)
		Shoe and link mounting method			Bolt
		Link pitch		in. (mm)	5.31 (135)
		Number of shoes (One side)		pcs.	40
		Track drive method			Link driving

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO55-5B
Undercarriage				
	Rubber track	Shoe width	in. (mm)	15.7 (400)
		Lug height	in. (mm)	0.98 (25)
		Core metal pitch	in. (mm)	2.97 (75.5)
	Carrier roller (Upper roller)	Manner of support		Overhung type
		Quantity (One side)	pcs.	1
		Bearing		Bearing
		Sealing		Shaft seal
	Number of shoe slide plates (One side)		pcs.	-
	Track roller (Lower roller)	Quantity (One side)	pcs.	4
		Bearing		Bush
		Sealing		Floating seal
	Idler	Quantity (One side)	pcs.	1
		Bearing		Bush
		Sealing		Floating seal
	Number of sprocket teeth	Steel track	pcs.	19
		Rubber track	pcs.	19
	Track tension adjustment			Grease adjuster

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5, ViO55-5
Engine					
Main specifications					
	Engine model				4TNV88-PBV
	Type				Vertical type series water-cooled 4 cycle diesel engine
	Combustion system				Direct injection
	Number of cylinders - Bore×Stroke			pcs. - in.×in. (mm×mm)	4 - 3.46×3.54 (88×90)
	Total displacement			cu.in. (cu.cm)	133.5 (2189)
	Rated output / engine speed			HP/rpm (KW/rpm)	38.7/2400 (28.8/2400)
	Maximum torque / engine speed			ft•lbf/rpm (N•m/rpm)	30.9 to 32.6/1300 (139.3 to 145.1/1300)
	Specific fuel consumption			lbs./HP•h (g/PS•h)	0.540 (245)
	Maximum idling speed			rpm	2510
	Minimum idling speed (engine unit)			rpm	1150
	Engine dry mass (excluding air cleaner and silencer)			lbs. (kg)	375 (170)
	Lubricating method				Forced lubrication by trochoid pump
	Specific lubricating oil consumption			lbs./HP•h (g/PS•h)	0.0012 or less (0.544 or less)
	Compression pressure			PSI (MPa)	497.7 (3.4) at 250 rpm
Cylinder head					
	Intake valve	Open	bTDC	degrees	10 to 20
		Close	aBDC	degrees	40 to 50
	Exhaust valve	Open	bBDC	degrees	51 to 61
		Close	aTDC	degrees	13 to 23
	Intake valve clearance (Cold engine)			in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
	Exhaust valve clearance (Cold engine)			in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
	Intake valve seat angle			degrees	120
	Exhaust valve seat angle			degrees	90
Piston					
	First compression ring	Ring shape			Barrel face (chrome-plated)
		Ring quantity		pcs.	4
	Second compression ring	Ring shape			Taper face (inner cut)
		Ring quantity		pcs.	4
	Oil-ring	Ring shape			Bevel cutter (with coil expander)
		Ring quantity		pcs.	4
Governor					
	Name				Mechanical all speed type
	Type				Centrifugal type

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5, ViO55-5
Engine				
	Fuel feed system			
		Fuel filter		Filter paper with automatic air release device
		Fuel filter filtration area	sq.in. (sq.cm)	310 (2000)
		Oil/water separator		Mesh filter
		Feed pump		Mechanical diaphragm type
	Lubrication system			
		Lubrication pump		Trochoid pump
		LO pressure regulating valve opening pressure	PSI (kPa)	42.7 to 56.9 (294.2 to 392.2)
		LO filter		Full flow filter
		LO filter filtration area	sq.in. (sq.cm)	186 (1200)
		Filter valve opening pressure	PSI (kPa)	11.4 to 17.1 (78.5 to 117.7)
		Operating pressure of alarm switch	PSI (kPa)	5.7 to 8.5 (39.2 to 58.8)
	Cooling device			
		Cooling system		Water-cooling (Radiator)
		Fan belt size		A38
		Thermostat opening temperature	ºF (ºC)	159.8 (71)
		Thermostat full-open temperature	ºF (ºC)	185.0 (85)
		Radiator cap pressure	PSI (kPa)	12.8 (88.3)
		Radiator fan	pcs.× Øin. (mm)	6×Ø13.2 (Ø335)
		Operating temperature of water temperature alarm switch	ºF (ºC)	224.6 to 235.4 (107 to 113)
	Air cleaner			
		Type		Cyclone type
		Filtration area	sq.ft. (sq.m)	11.8 (1.1)
	Fuel injection pump			
		Injection pump type		YPD-4MP2
		Injection pump plunger diameter	in. (mm)	Ø0.35 (Ø9)
		Injection pump cam lifting height	in. (mm)	0.28 (7.0)
		Fuel injection timing (FID)	degrees	16
		Firing order		1→3→4→2
	Nozzle			
		Type		Hall valve
		Nozzle hole diameter×Number of holes	Øin. (mm) ×pcs.	Ø0.0071 (Ø0.18)×4
		Spray angle	degrees	159
		Fuel injection pressure	PSI (MPa)	2844 to 2986 (19.6 to 20.6)
	Turbocharger			
		Type		-
		Revolution speed	rpm	-
		Turbocharging pressure	PSI (MPa)	-

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5, ViO55-5
Engine				
	Starting device			
		Cold starting aids		Air heater
		Starting aids capacity	V-W	12-400
		Battery type		115D31R
		Battery voltage - 5 hrs rate capacity	V-Ah	12-72
Electrical equipment				
		Alternator — Type		Magnet
		Alternator — Nominal output	V-A	12-40
		Alternator — Rated speed	rpm	5000
		Regulator — Type		IC type
		Regulator — Regulation voltage	V	14.2 to 14.8
		Starter motor — Type		Reduction type
		Starter motor — Nominal output	V-kW	12-2.3
		Starter motor — Engagement		Magnet shift
		Stop motor — Type	-	-
		Stop motor — Nominal output	V-A	-
		Hour meter	V-W	12-12
		Horn	V-W	12-30
		Fuse	A×pcs.	30×1, 15×5, 5×1
		Monitor lamps — Battery charge alarm lamp	V-W	12-2
		Monitor lamps — Engine oil pressure alarm lamp	V-W	12-2
		Monitor lamps — Water temperature alarm lamp	V-W	12-2
		Headlight	V-W	12-55
		Boom light	V-W	12-55
		Room lamp (for cabin)	V-W	12-5
		Wiper motor (for cabin)	V-W	12-48
		Cabin heater (for cabin)	V-W	12-35
		External energizer socket	V-W	12-120

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item				Unit	ViO45-5B, ViO55-5B
Engine					
Main specifications					
Engine model					4TNV88-BXBV
Type					Vertical type series water-cooled 4 cycle diesel engine
Combustion system					Direct injection
Number of cylinders - Bore×Stroke				pcs. - in.×in. (mm×mm)	4 - 3.46×3.54 (88×90)
Total displacement				cu.in. (cu.cm)	133.5 (2189)
Rated output / engine speed				HP/rpm (KW/rpm)	38.7/2400 (28.8/2400)
Maximum torque / engine speed				ft•lbf/rpm (N•m/rpm)	30.9 to 32.6/1300 (139.3 to 145.1/1300)
Specific fuel consumption				lbs./HP•h (g/PS•h)	0.540 (245)
Maximum idling speed				rpm	2510
Minimum idling speed (engine unit)				rpm	1150
Engine dry mass (excluding air cleaner and silencer)				lbs. (kg)	375 (170)
Lubricating method					Forced lubrication by trochoid pump
Specific lubricating oil consumption				lbs./HP•h (g/PS•h)	0.0012 or less (0.544 or less)
Compression pressure				PSI (MPa)	497.7 (3.4) at 250 rpm
Cylinder head					
Intake valve	Open	bTDC		degrees	10 to 20
	Close	aBDC		degrees	40 to 50
Exhaust valve	Open	bBDC		degrees	51 to 61
	Close	aTDC		degrees	13 to 23
Intake valve clearance (Cold engine)				in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
Exhaust valve clearance (Cold engine)				in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)
Intake valve seat angle				degrees	120
Exhaust valve seat angle				degrees	90
Piston					
First compression ring	Ring shape				Barrel face (chrome-plated)
	Ring quantity			pcs.	4
Second compression ring	Ring shape				Taper face (inner cut)
	Ring quantity			pcs.	4
Oil-ring	Ring shape				Bevel cutter (with coil expander)
	Ring quantity			pcs.	4
Governor					
Name					Mechanical all speed type
Type					Centrifugal type

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5B, ViO55-5B
Engine				
	Fuel feed system			
		Fuel filter		Filter paper with automatic air release device
		Fuel filter filtration area	sq.in. (sq.cm)	310 (2000)
		Oil/water separator		Mesh filter
		Feed pump		Mechanical diaphragm type
	Lubrication system			
		Lubrication pump		Trochoid pump
		LO pressure regulating valve opening pressure	PSI (kPa)	42.7 to 56.9 (294.2 to 392.2)
		LO filter		Full flow filter
		LO filter filtration area	sq.in. (sq.cm)	186 (1200)
		Filter valve opening pressure	PSI (kPa)	11.4 to 17.1 (78.5 to 117.7)
		Operating pressure of alarm switch	PSI (kPa)	5.7 to 8.5 (39.2 to 58.8)
	Cooling device			
		Cooling system		Water-cooling (Radiator)
		Fan belt size		A38
		Thermostat opening temperature	ºF (ºC)	159.8 (71)
		Thermostat full-open temperature	ºF (ºC)	185.0 (85)
		Radiator cap pressure	PSI (kPa)	12.8 (88.3)
		Radiator fan	pcs.× Øin. (mm)	6×Ø13.2 (Ø335)
		Operating temperature of water temperature alarm switch	ºF (ºC)	224.6 to 235.4 (107 to 113)
	Air cleaner			
		Type		Cyclone type
		Filtration area	sq.ft. (sq.m)	11.8 (1.1)
	Fuel injection pump			
		Injection pump type		YPD-4MP2
		Injection pump plunger diameter	in. (mm)	Ø0.35 (Ø9)
		Injection pump cam lifting height	in. (mm)	0.28 (7.0)
		Fuel injection timing (FID)	degrees	16
		Firing order		1→3→4→2
	Nozzle			
		Type		Hall valve
		Nozzle hole diameter×Number of holes	Øin. (mm) ×pcs.	Ø0.0071 (Ø0.18)×4
		Spray angle	degrees	159
		Fuel injection pressure	PSI (MPa)	2844 to 2986 (19.6 to 20.6)
	Turbocharger			
		Type		-
		Revolution speed	rpm	-
		Turbocharging pressure	PSI (MPa)	-

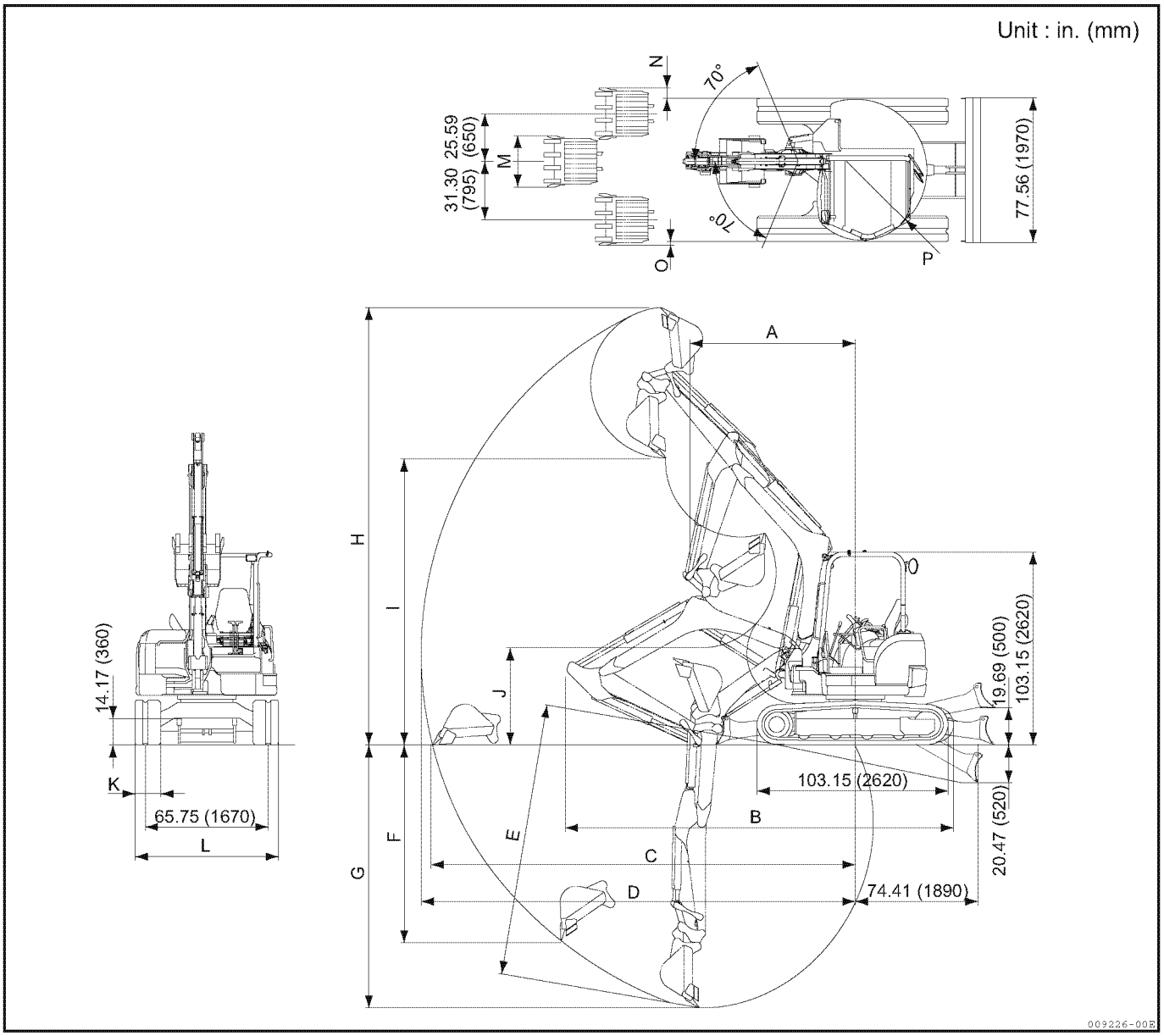
2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

Item			Unit	ViO45-5B, ViO55-5B
Engine				
	Starting device			
		Cold starting aids		Air heater
		Starting aids capacity	V-W	12-400
		Battery type		115D31R
		Battery voltage - 5 hrs rate capacity	V-Ah	12-72
Electrical equipment				
		Alternator	Type		Magnet
			Nominal output	V-A	12-40
			Rated speed	rpm	5000
		Regulator	Type		IC type
			Regulation voltage	V	14.2 to 14.8
		Starter motor	Type		Reduction type
			Nominal output	V-kW	12-2.3
			Engagement		Magnet shift
		Stop motor	Type	-	-
			Nominal output	V-A	-
		Hour meter		V-W	12-12
		Horn		V-W	12-30
		Fuse		A×pcs.	30×1, 15×5, 5×1
		Monitor lamps	Battery charge alarm lamp	V-W	12-2
			Engine oil pressure alarm lamp	V-W	12-2
			Water temperature alarm lamp	V-W	12-2
			Glow plug pilot lamp	V-W	12-2
		Headlight		V-W	12-55
		Boom light		V-W	12-55
		Room lamp (for cabin)		V-W	12-5
		Wiper motor (for cabin)		V-W	12-48
		Cabin heater (for cabin)		V-W	12-35
		External energizer socket		V-W	12-120

2-2 Outline Drawing and Working Area

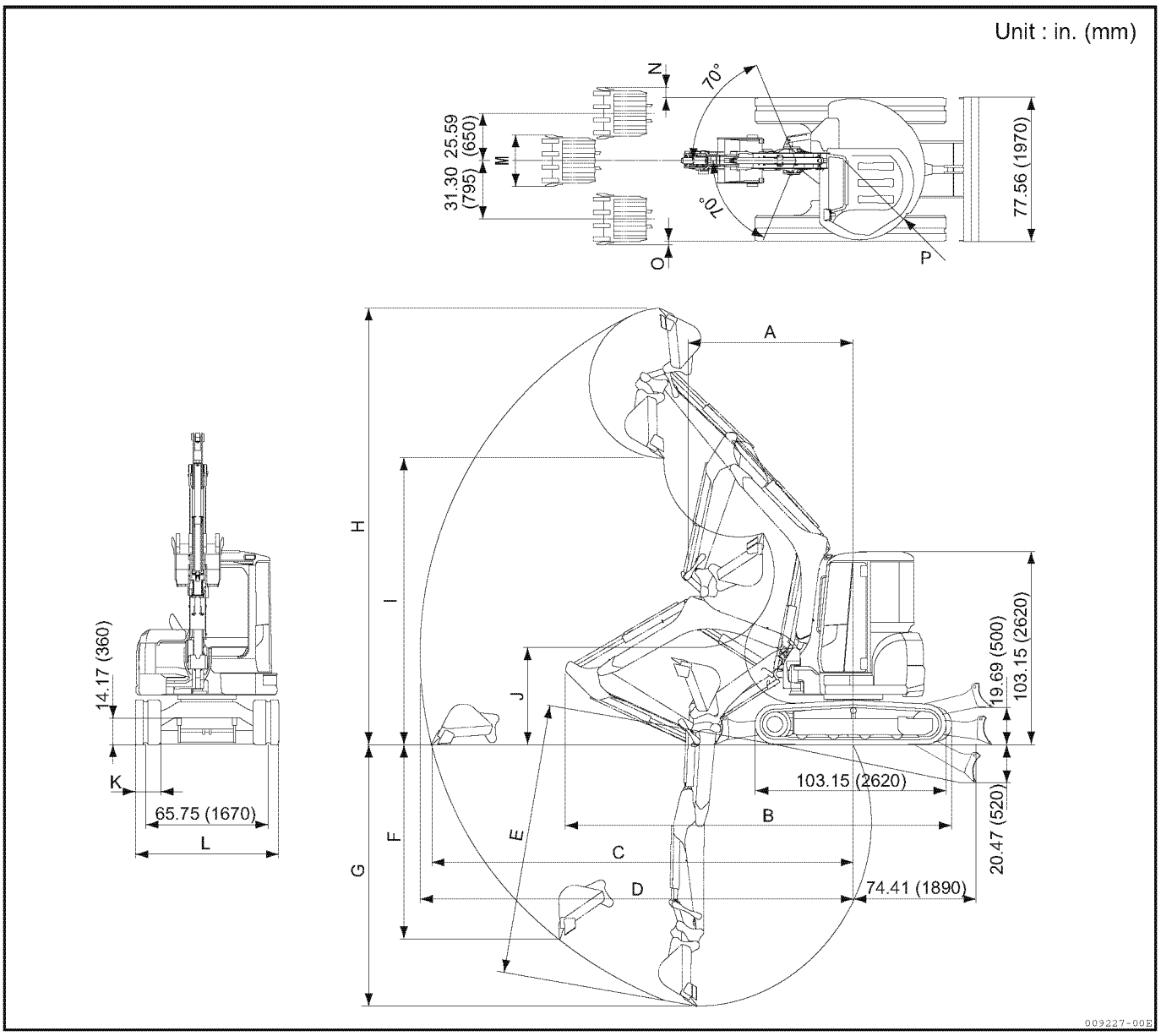
2-2-1 Canopy type



	A <at boom swing>	B	C	D	E	F	G	H	I	J
ViO45-5 ViO45-5B	92.13 <78.35> (2340 <1990>)	207.09 (5260)	226.38 (5750)	232.28 (5900)	151.57 (3850)	106.30 (2700)	144.88 (3680)	234.25 (5950)	153.94 (3910)	52.36 (1330)
ViO55-5 ViO55-5B	91.34 <77.17> (2320 <1960>)	218.90 (5560)	244.09 (6200)	250.00 (6350)	163.78 (4160)	114.17 (2900)	156.69 (3980)	253.54 (6440)	173.23 (4400)	59.84 (1520)

	K	L	M	N	O	P
ViO45-5 ViO45-5B	13.78 (350)	76.77 (1950)	25.59 (650)	5.12 (130)	1.57 (40)	R38.39 (R975)
ViO55-5 ViO55-5B	15.75 (400)	78.35 (1990)	27.56 (700)	5.31 (135)	1.77 (45)	R39.17 (R995)

2-2-2 Cabin type



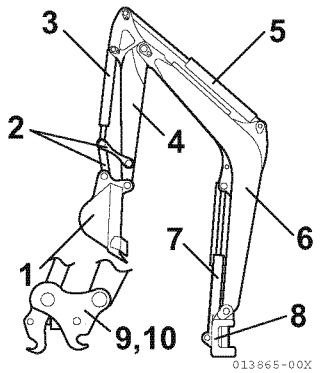
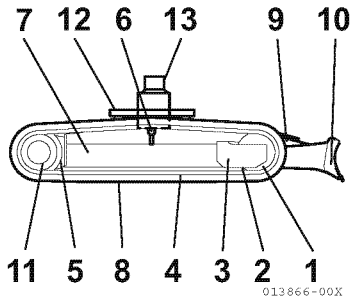
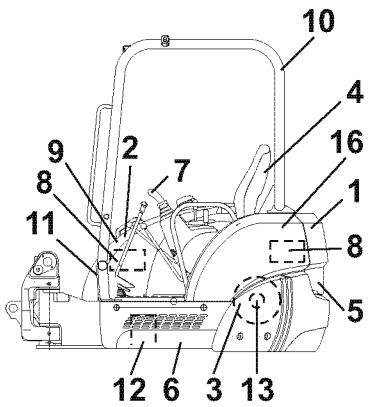
	A <at boom swing>	B	C	D	E	F	G	H	I	J
ViO45-5 ViO45-5B	92.13 <78.35> (2340 <1990>)	207.09 (5260)	226.38 (5750)	232.28 (5900)	151.57 (3850)	106.30 (2700)	144.88 (3680)	234.25 (5950)	153.94 (3910)	52.36 (1330)
ViO55-5 ViO55-5B	91.34 <77.17> (2320 <1960>)	218.90 (5560)	244.09 (6200)	250.00 (6350)	163.78 (4160)	114.17 (2900)	156.69 (3980)	253.54 (6440)	173.23 (4400)	59.84 (1520)

	K	L	M	N	O	P
ViO45-5 ViO45-5B	13.78 (350)	76.77 (1950)	25.59 (650)	5.12 (130)	1.57 (40)	R38.39 (R975)
ViO55-5 ViO55-5B	15.75 (400)	78.35 (1990)	27.56 (700)	5.31 (135)	1.77 (45)	R39.17 (R995)

2-3 Weight List of Main Parts

Note : *< > : W/O Quick coupler*

[Unit : lbs. (kg)]

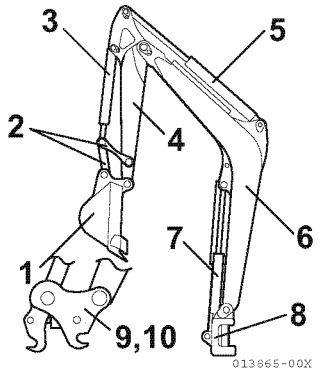
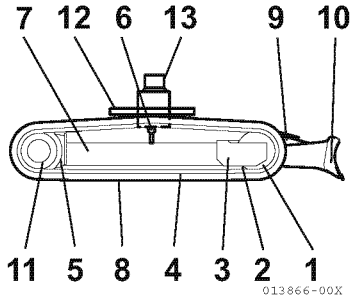
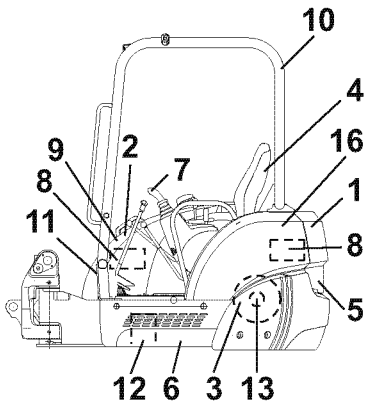
Equipment	No.	Part	ViO45-5			
			Canopy		Cabin	
			Steel track	Rubber track	Steel track	Rubber track
Front implement						
	1	Bucket Ass'y	271.2 (123)			
	2	Bucket arm & link Ass'y	61.7 (28)			
	3	Bucket cylinder Ass'y	70.6 (32)			
	4	Arm Ass'y	196.2 (89)			
	5	Arm cylinder Ass'y	94.8 (43)			
	6	Boom Ass'y	374.9 (170)			
	7	Boom cylinder Ass'y	✱1 : 90.4 (41), ✱2 : 113.0 (52)			
	8	Boom bracket Ass'y	209.5 (95)			
	9	Quick coupler cylinder Ass'y	19.4 (8.8)			
	10	Quick coupler Ass'y	103.2 (46.8)			
Undercarriage						
	1	Idler Ass'y	81.6 (37)			
	2	Track guard Ass'y	9.26×2 [(4.2)×2]	–	9.26×2 [(4.2)×2]	–
	3	Track adjuster Ass'y	44.1 (20) × 2			
	4	Track roller Ass'y	27.6 (12.5) × 8			
	5	Sprocket Ass'y	28.7 (13) × 2			
	6	Carrier roller Ass'y	22.1 (10) × 2			
	7	Track frame Ass'y	1125 (510)			
	8	Steel track & Rubber track Ass'y	560.1×2 [(254)×2]	518.2×2 [(235)×2]	560.1×2 [(254)×2]	518.2×2 [(235)×2]
	9	Blade cylinder Ass'y	70.6 (32)			
	10	Blade Ass'y	555.7 (252) <507.2 (230)>			
	11	Travel motor Ass'y	121.3 (55) × 2			
	12	Swing bearing Ass'y	196.2 (89)			
	13	Swivel & hose or fitting Ass'y	66.2 (30)			
Upperstructure						
	1	Engine hood Ass'y	66.2 (30)			
	2	Hydraulic oil tank with filter Ass'y	83.8 (38)			
	3	Engine	551.3 (250)			
	4	Operator's seat & mount Ass'y	123.5 (56)			
	5	Counter weight Ass'y	258 (117)			
	6	Turning frame Ass'y	1226 (556)			
	7	Controls (4 cables) Ass'y	66.2 (30)			
	8	Battery Ass'y	48.5 (22)			
	9	Fuel tank & piping Ass'y	83.8 (38)			
	10	Canopy (& pole) or cabin Ass'y	132.3 (60)		507.2 (230)	
	11	Swing lock, covers, steps and panels	136.7 (62)			
	12	Swing motor Ass'y	92.6 (42)			
	13	Pump & mount and hoses Ass'y	88.2 (40)			
	14	Control valve & fitting and hoses Ass'y	143.3 (65)			
	15	Boom swing cylinder Ass'y	70.6 (32)			
	16	Engine mount Ass'y	224.9 (102)			

✱1 : S/N 50501 to 50591, ✱2 : S/N 50592 and after

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

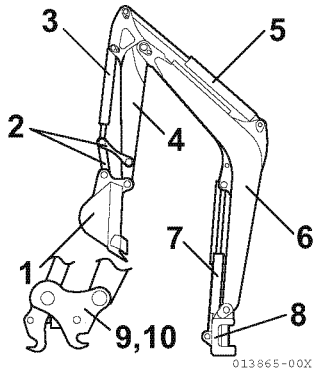
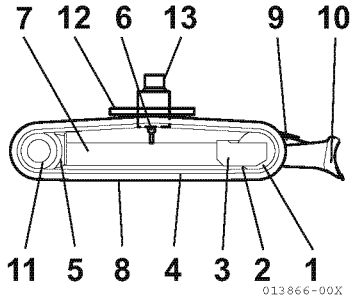
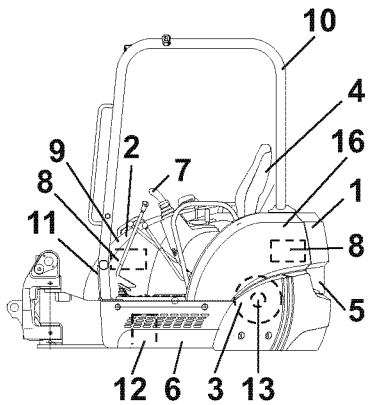
[Unit : lbs. (kg)]

Equipment	No.	Part	ViO45-5B			
			Canopy		Cabin	
			Steel track	Rubber track	Steel track	Rubber track
Front implement						
	1	Bucket Ass'y	271.2 (123)			
	2	Bucket arm & link Ass'y	61.7 (28)			
	3	Bucket cylinder Ass'y	70.6 (32)			
	4	Arm Ass'y	196.2 (89)			
	5	Arm cylinder Ass'y	94.8 (43)			
	6	Boom Ass'y	542.3 (246)			
	7	Boom cylinder Ass'y	113.0 (52)			
	8	Boom bracket Ass'y	209.5 (95)			
	9	Quick coupler cylinder Ass'y	19.4 (8.8)			
	10	Quick coupler Ass'y	103.2 (46.8)			
Undercarriage						
	1	Idler Ass'y	81.6 (37)			
	2	Track guard Ass'y	9.26×2 [(4.2)×2]	–	9.26×2 [(4.2)×2]	–
	3	Track adjuster Ass'y	44.1 (20) × 2			
	4	Track roller Ass'y	27.6 (12.5) × 8			
	5	Sprocket Ass'y	28.7 (13) × 2			
	6	Carrier roller Ass'y	22.1 (10) × 2			
	7	Track frame Ass'y	1125 (510)			
	8	Steel track & Rubber track Ass'y	560.1×2 [(254)×2]	518.2×2 [(235)×2]	560.1×2 [(254)×2]	518.2×2 [(235)×2]
	9	Blade cylinder Ass'y	70.6 (32)			
	10	Blade Ass'y	555.7 (252) <507.2 (230)>			
	11	Travel motor Ass'y	121.3 (55) × 2			
	12	Swing bearing Ass'y	196.2 (89)			
	13	Swivel & hose or fitting Ass'y	66.2 (30)			
Upperstructure						
	1	Engine hood Ass'y	66.2 (30)			
	2	Hydraulic oil tank with filter Ass'y	83.8 (38)			
	3	Engine	551.3 (250)			
	4	Operator's seat & mount Ass'y	123.5 (56)			
	5	Counter weight Ass'y	258 (117)			
	6	Turning frame Ass'y	1278.7(580)			
	7	Controls (4 cables) Ass'y	66.2 (30)			
	8	Battery Ass'y	48.5 (22)			
	9	Fuel tank & piping Ass'y	83.8 (38)			
	10	Canopy (& pole) or cabin Ass'y	132.3 (60)		507.2 (230)	
	11	Swing lock, covers, steps and panels	136.7 (62)			
	12	Swing motor Ass'y	92.6 (42)			
	13	Pump & mount and hoses Ass'y	88.2 (40)			
	14	Control valve & fitting and hoses Ass'y	143.3 (65)			
	15	Boom swing cylinder Ass'y	70.6 (32)			
	16	Engine mount Ass'y	224.9 (102)			

2. TECHNICAL DATA

Note : *< > : W/O Quick coupler*

[Unit : lbs. (kg)]

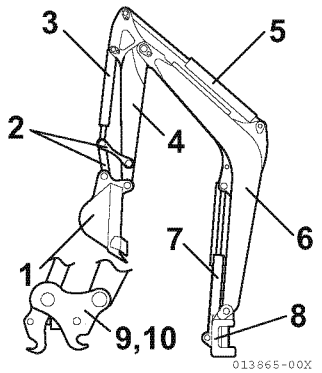
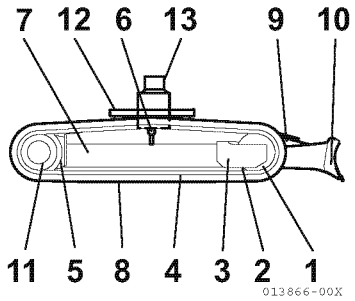
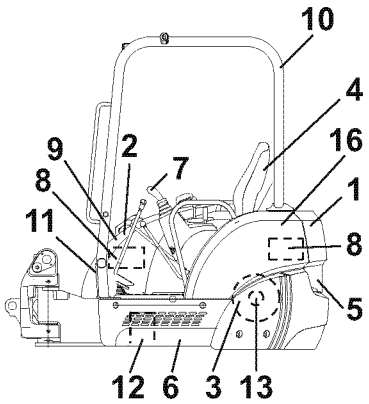
Equipment	No.	Part	ViO55-5			
			Canopy		Cabin	
			Steel track	Rubber track	Steel track	Rubber track
Front implement						
	1	Bucket Ass'y	277.8 (126)			
	2	Bucket arm & link Ass'y	61.7 (28)			
	3	Bucket cylinder Ass'y	70.6 (32)			
	4	Arm Ass'y	235.9 (107)			
	5	Arm cylinder Ass'y	94.8 (43)			
	6	Boom Ass'y	502.7 (228)			
	7	Boom cylinder Ass'y	✱1 : 90.4 (41), ✱2 : 113.0 (52)			
	8	Boom bracket Ass'y	209.5 (95)			
	9	Quick coupler cylinder Ass'y	19.4 (8.8)			
	10	Quick coupler Ass'y	103.2 (46.8)			
Undercarriage						
	1	Idler Ass'y	81.6 (37)			
	2	Track guard Ass'y	9.26×2 [(4.2)×2]	–	9.26×2 [(4.2)×2]	–
	3	Track adjuster Ass'y	44.1 (20) × 2			
	4	Track roller Ass'y	27.6 (12.5) × 8			
	5	Sprocket Ass'y	28.7 (13) × 2			
	6	Carrier roller Ass'y	22.1 (10) × 2			
	7	Track frame Ass'y	1125 (510)			
	8	Steel track & Rubber track Ass'y	626.2×2 [(284)×2]	577.7×2 [(262)×2]	626.2×2 [(284)×2]	577.7×2 [(262)×2]
	9	Blade cylinder Ass'y	70.6 (32)			
	10	Blade Ass'y	555.7 (252) <507.2 (230)>			
	11	Travel motor Ass'y	121.3 (55) × 2			
	12	Swing bearing Ass'y	196.2 (89)			
	13	Swivel & hose or fitting Ass'y	66.2 (30)			
Upperstructure						
	1	Engine hood Ass'y	66.2 (30)			
	2	Hydraulic oil tank with filter Ass'y	83.8 (38)			
	3	Engine	551.3 (250)			
	4	Operator's seat & mount Ass'y	123.5 (56)			
	5	Counter weight Ass'y	1292 (586)			
	6	Turning frame Ass'y	1226 (556)			
	7	Controls (4 cables) Ass'y	66.2 (30)			
	8	Battery Ass'y	48.5 (22)			
	9	Fuel tank & piping Ass'y	83.8 (38)			
	10	Canopy (& pole) or cabin Ass'y	132.3 (60)		507.2 (230)	
	11	Swing lock, covers, steps and panels	136.7 (62)			
	12	Swing motor Ass'y	92.6 (42)			
	13	Pump & mount and hoses Ass'y	88.2 (40)			
	14	Control valve & fitting and hoses Ass'y	143.3 (65)			
	15	Boom swing cylinder Ass'y	70.6 (32)			
	16	Engine mount Ass'y	224.9 (102)			

✱1 : S/N 50501 to 50800, ✱2 : S/N 50801 and after

2. TECHNICAL DATA

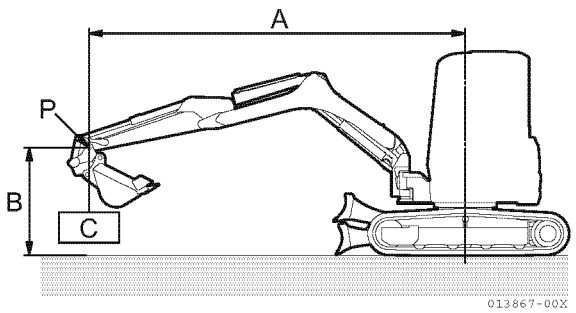
Note : *< > : W/O Quick coupler*

[Unit : lbs. (kg)]

Equipment	No.	Part	ViO55-5B			
			Canopy		Cabin	
			Steel track	Rubber track	Steel track	Rubber track
Front implement						
	1	Bucket Ass'y	277.8 (126)			
	2	Bucket arm & link Ass'y	61.7 (28)			
	3	Bucket cylinder Ass'y	70.6 (32)			
	4	Arm Ass'y	235.9 (107)			
	5	Arm cylinder Ass'y	94.8 (43)			
	6	Boom Ass'y	596.3 (270.5)			
	7	Boom cylinder Ass'y	113.0 (52)			
	8	Boom bracket Ass'y	209.5 (95)			
	9	Quick coupler cylinder Ass'y	19.4 (8.8)			
	10	Quick coupler Ass'y	103.2 (46.8)			
Undercarriage						
	1	Idler Ass'y	81.6 (37)			
	2	Track guard Ass'y	9.26×2 [(4.2)×2]	–	9.26×2 [(4.2)×2]	–
	3	Track adjuster Ass'y	44.1 (20) × 2			
	4	Track roller Ass'y	27.6 (12.5) × 8			
	5	Sprocket Ass'y	28.7 (13) × 2			
	6	Carrier roller Ass'y	22.1 (10) × 2			
	7	Track frame Ass'y	1125 (510)			
	8	Steel track & Rubber track Ass'y	626.2×2 [(284)×2]	577.7×2 [(262)×2]	626.2×2 [(284)×2]	577.7×2 [(262)×2]
	9	Blade cylinder Ass'y	99.2 (45)			
	10	Blade Ass'y	555.7 (252) <507.2 (230)>			
	11	Travel motor Ass'y	121.3 (55) × 2			
	12	Swing bearing Ass'y	196.2 (89)			
	13	Swivel & hose or fitting Ass'y	66.2 (30)			
Upperstructure						
	1	Engine hood Ass'y	66.2 (30)			
	2	Hydraulic oil tank with filter Ass'y	83.8 (38)			
	3	Engine	551.3 (250)			
	4	Operator's seat & mount Ass'y	123.5 (56)			
	5	Counter weight Ass'y	1292 (586)			
	6	Turning frame Ass'y	1278.7 (580)			
	7	Controls (4 cables) Ass'y	66.2 (30)			
	8	Battery Ass'y	48.5 (22)			
	9	Fuel tank & piping Ass'y	83.8 (38)			
	10	Canopy (& pole) or cabin Ass'y	132.3 (60)		507.2 (230)	
	11	Swing lock, covers, steps and panels	136.7 (62)			
	12	Swing motor Ass'y	92.6 (42)			
	13	Pump & mount and hoses Ass'y	88.2 (40)			
	14	Control valve & fitting and hoses Ass'y	143.3 (65)			
	15	Boom swing cylinder Ass'y	70.6 (32)			
	16	Engine mount Ass'y	224.9 (102)			

2-4 Lifting Capacity List

1) ViO45-5, ViO45-5B



With:
(□ Cabin■ Canopy) Type
(□ Steel ■ Rubber) Track
Quick coupler
W/O Bucket

A : Reach from swing center line [in. (m)]
B : Load point height [in. (m)]
C : Lifting load [lbs. (kg)]
P : Load point
: Rating over front
: Rating over side or 180 degrees

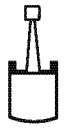
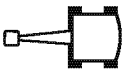
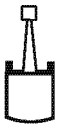
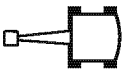
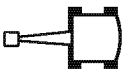
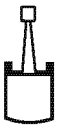
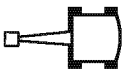
Blade on ground

Unit : lbs. (kg)

A [in. (m)]	Max.		157.5 (4.0)		118.1 (3.0)		98.43 (2.5)	
B [in. (m)]								
157.5 (4.0)	*1851 (840)		–		–		–	
118.1 (3.0)	*1918 (870)		*1851 (840)		–		–	
78.7 (2.0)	*2006 (910)		*2160 (980)		*2733 (1240)		*3284 (1490)	
39.4 (1.0)	*2116 (960)		*2557 (1160)		*3659 (1660)		*4651 (2110)	
0 (0)	*2226 (1010)		*2755 (1250)		*3990 (1810)		*5026 (2280)	
-39.4 (-1.0)	*2336 (1060)		*2645 (1200)		*3769 (1710)		*4872 (2210)	
-78.7 (-2.0)	*2336 (1060)		–		*2777 (1260)		*3373 (1530)	

Blade above ground

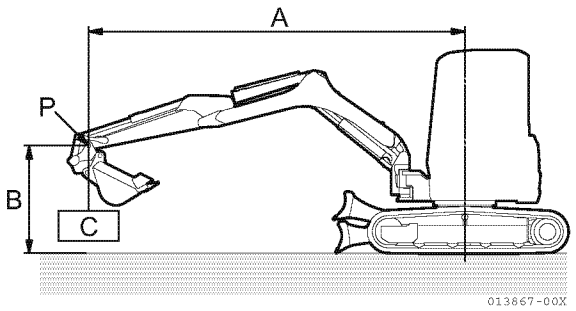
Unit : lbs. (kg)

A [in. (m)]	Max.		157.5 (4.0)		118.1 (3.0)		98.43 (2.5)	
B [in. (m)]								
157.5 (4.0)	*1741 (790)	*1763 (800)	–	–	–	–	–	–
118.1 (3.0)	1234 (560)	1102 (500)	*1741 (790)	1410 (640)	–	–	–	–
78.7 (2.0)	992 (450)	903 (410)	1455 (660)	1322 (600)	*2513 (1140)	*2623 (1190)	*3196 (1450)	*3218 (1460)
39.4 (1.0)	947 (430)	859 (390)	1366 (620)	1234 (560)	2204 (1000)	2006 (910)	2932 (1330)	2623 (1190)
0 (0)	992 (450)	903 (410)	1300 (590)	1168 (530)	2050 (930)	1851 (840)	2711 (1230)	2447 (1110)
-39.4 (-1.0)	1168 (530)	1058 (480)	1300 (590)	1168 (530)	2028 (920)	2028 (920)	2821 (1280)	3284 (1490)
-78.7 (-2.0)	1895 (860)	1785 (810)	–	–	2160 (980)	1984 (900)	2821 (1280)	2557 (1160)

Note :

The lifting load with the asterisk (*) mark is limited by hydraulic lifting capacity rather than tipping. The lifting capacity shown in the above list is based on the ISO Standard No. 10567 and represents either 87 % of hydraulic lifting capacity or 75 % of tipping load, which is smaller.

2) ViO55-5, ViO55-5B



With:
(☐ Cabin■ Canopy) Type
(☐ Steel ■ Rubber) Track
Quick coupler
W/O Bucket

A : Reach from swing center line [in. (m)]
B : Load point height [in. (m)]
C : Lifting load [lbs. (kg)]
P : Load point
: Rating over front
: Rating over side or 180 degrees

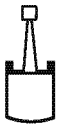
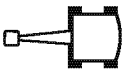
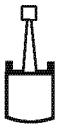
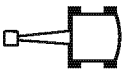
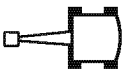
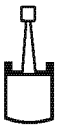
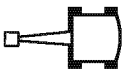
Blade on ground

Unit : lbs. (kg)

A [in. (m)]	Max.		157.5 (4.0)		118.1 (3.0)		98.43 (2.5)	
B [in. (m)]								
157.5 (4.0)	*2006 (910)		*1873 (850)		–		–	
118.1 (3.0)	*1962 (890)		*1984 (900)		–		–	
78.7 (2.0)	*2050 (930)		*2447 (1110)		*3218 (1460)		*4078 (1850)	
39.4 (1.0)	*2138 (970)		*2888 (1310)		*4188 (1900)		*5511 (2500)	
0 (0)	*2182 (990)		*3130 (1420)		*4519 (2050)		*5621 (2550)	
-39.4 (-1.0)	*2248 (1020)		*2998 (1360)		*4232 (1920)		*5246 (2380)	
-78.7 (-2.0)	*2160 (980)		–		*3439 (1560)		*4034 (1830)	

Blade above ground

Unit : lbs. (kg)

A [in. (m)]	Max.		157.5 (4.0)		118.1 (3.0)		98.43 (2.5)	
B [in. (m)]								
157.5 (4.0)	*1873 (850)	*1940 (880)	*1807 (820)	*1873 (850)	–	–	–	–
118.1 (3.0)	1300 (590)	1234 (560)	*2028 (920)	*1962 (890)	–	–	–	–
78.7 (2.0)	1190 (540)	1102 (500)	1962 (890)	1829 (830)	*3086 (1400)	*3196 (1450)	*3880 (1760)	*4056 (1840)
39.4 (1.0)	1124 (510)	1036 (470)	1829 (830)	1697 (770)	2910 (1320)	2645 (1200)	3769 (1710)	3527 (1600)
0 (0)	1168 (530)	1102 (500)	1719 (780)	1631 (740)	2689 (1220)	2513 (1140)	3549 (1610)	3240 (1470)
-39.4 (-1.0)	1344 (610)	1256 (570)	1697 (770)	1609 (730)	2733 (1240)	2491 (1130)	3659 (1660)	3351 (1520)
-78.7 (-2.0)	*2138 (970)	*2006 (910)	–	–	2821 (1280)	2579 (1170)	4254 (1930)	3395 (1540)

Note :

The lifting load with the asterisk (*) mark is limited by hydraulic lifting capacity rather than tipping. The lifting capacity shown in the above list is based on the ISO Standard No. 10567 and represents either 87 % of hydraulic lifting capacity or 75 % of tipping load, which is smaller.

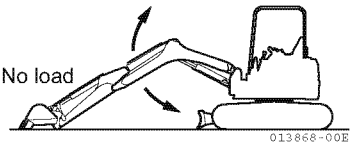
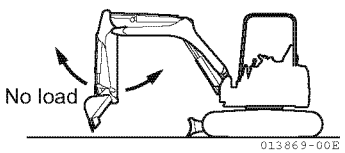
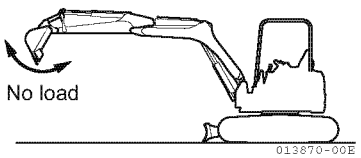
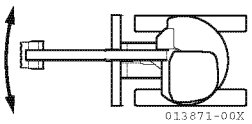
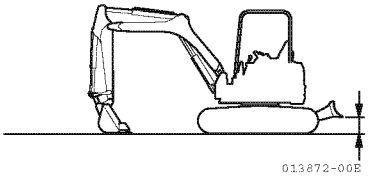
CHAPTER 3

SERVICE STANDARDS

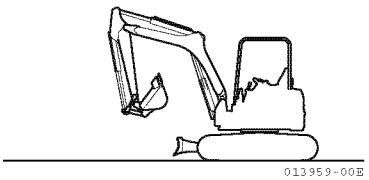
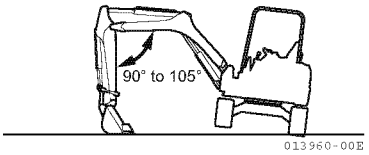
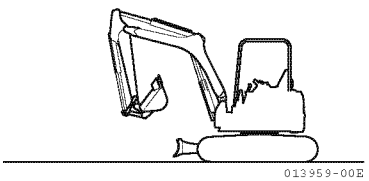
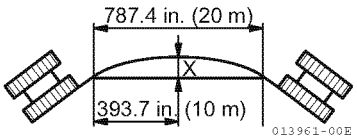
3-1 Machine Performance 3-1-1
3-2 Engine 3-2-1
3-3 Undercarriage 3-3-1
3-3-1 Rubber Track Specifications 3-3-1
3-3-2 Steel Track Specifications 3-3-2
3-3-3 Common Specifications of Steel & Rubber Tracks 3-3-3
3-4 Controls 3-4-1
3-5 Hydraulic Equipment 3-5-1
3-5-1 Hydraulic Cylinders 3-5-1
3-6 Implement 3-6-1
3-6-1 Front Attachments 3-6-1
3-6-2 Blade Moving Device 3-6-2
3-6-3 Bucket Teeth 3-6-2
3-7 List of Tightening Torque 3-7-1
3-7-1 Machine 3-7-1
3-7-2 Engine 3-7-4
3-7-3 Tightening Torque for General Bolts and Nuts 3-7-4

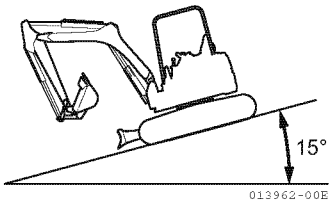
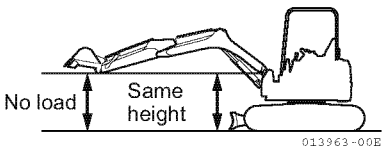
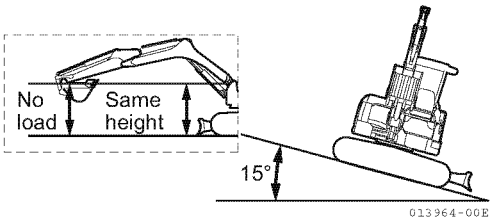
3. Service Standards

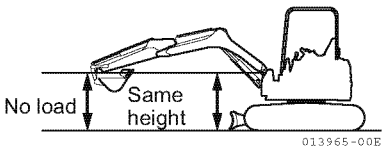
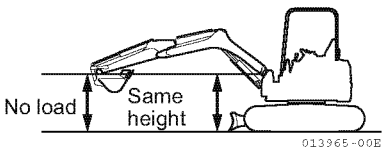
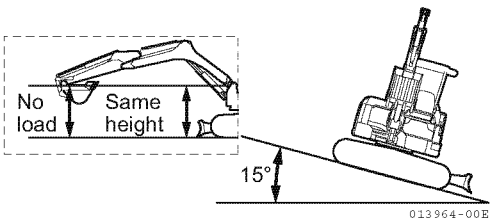
3-1 Machine Performance

Applicable model				ViO45-5 ViO45-5B		ViO55-5 ViO55-5B	
Item	Measuring condition		Unit	Standard	Allowance	Standard	Allowance
Machine performance							
Working speed							
Boom speed Max. cylinder extension Bucket teeth grounded	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Up	sec.	✱1 : 2.2 ✱2 : 2.4	✱1 : 2.5 ✱2 : 2.7	✱1 : 2.2 ✱2 : 2.6	✱1 : 2.5 ✱2 : 2.9
		Down		✱1 : 2.5 ✱2 : 2.9	✱1 : 2.8 ✱2 : 3.2	✱1 : 2.5 ✱2 : 3.2	✱1 : 2.8 ✱2 : 3.5
Arm speed Max. cylinder retraction Max. cylinder extension	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Extend	sec.	2.5	2.8	2.5	2.8
		Retract		3.4	3.7	3.4	3.7
Bucket speed Max. cylinder retraction Max. cylinder extension	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Dump	sec.	2.4	2.7	2.4	2.7
		Curl		4.0	4.3	4.0	4.3
Boom offset speed Max. cylinder retraction Max. cylinder extension	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground	Right swing	sec.	6.5	8.0	6.5	8.0
		Left swing		6.5	8.0	6.5	8.0
Blade speed Max. cylinder retraction Blade grounded	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C)	Up	sec.	0.9	1.2	1.0	1.3
		Down		1.1	1.4	1.2	1.5

ViO45-5, ViO45-5B : ✱1 : S/N 50501 to 50591, ✱2 : S/N 50592 and after
ViO55-5, ViO55-5B : ✱1 : S/N 50501 to 50800, ✱2 : S/N 50801 and after

Applicable model			ViO45-5 ViO45-5B		ViO55-5 ViO55-5B	
Item	Measuring condition	Unit	Standard	Allowance	Standard	Allowance
Machine performance						
Travel speed	Machine position  013959-00E • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Traveling time for 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more.	sec./ 787.4 in. (20 m)	High speed 15.6	17.1	16.4	18.0
			Low speed 32.0	35.0	32.0	35.0
Track speed	Machine position  013960-00E • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Travel lever : Full throttle (Floating track side) • Float one side of the track. Make a mark on the track. After turning the floating track side more than once, measure the time needed for 3 turns of the track.	sec./ 3 rev.	High speed 12.6	15.6	13.3	16.3
			Low speed 26.1	30.0	25.0	29.0
Track deviation	Machine position  013959-00E • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Measure the deviation (χ) in a travel distance of 787.4 in. (20 m) after an approach run of 196.9 in. (5 m) or more.  013961-00E	in. (mm)/ 787.4 in. (20 m)	11.8 (300) or less	14.2 (360)	11.8 (300) or less	14.2 (360) or less

Applicable model			ViO45-5 ViO45-5B		ViO55-5 ViO55-5B	
Item	Measuring condition	Unit	Standard	Allowance	Standard	Allowance
Machine performance						
Traveling drift	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Drift of the machine after 5 min. on a slope with an inclination of 15 degrees.	in. (mm) / 5 min.	7.87 (200) or less	11.8 (300)	7.87 (200) or less	11.8 (300)
Drift of cylinders						
Boom drift (Cylinder rod retraction)	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make the boom and bucket pins the same height. • Measure the retraction or extension of each cylinder rod after leaving the machine at the above position for 10 min. • Lift the blade to the highest position, and measure the cylinder rod extension after 10 min.	in. (mm) / 10 min.	0.39 (10) or less	0.59 (15)	0.39 (10) or less	0.59 (15)
Arm drift (Cylinder rod extension)			0.39 (10) or less	0.59 (15)	0.39 (10) or less	0.59 (15)
Bucket drift (Cylinder rod extension)			0.24 (6) or less	0.35 (9)	0.24 (6) or less	0.35 (9)
Blade drift (Cylinder rod extension)			0.24 (6) or less	0.35 (9)	0.24 (6) or less	0.35 (9)
Boom offset drift (Cylinder rod extension)	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the track and engage the swing lock. • Measure the cylinder rod extension after 10 min.	in. (mm) / 10 min.	0.24 (6) or less	0.35 (9)	0.24 (6) or less	0.35 (9)

Applicable model			ViO45-5 ViO45-5B		ViO55-5 ViO55-5B	
Item	Measuring condition	Unit	Standard	Allowance	Standard	Allowance
Machine performance						
Swing drift at stopping	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make the boom and bucket pins the same height. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance between both marks after making one turn with no load.	in. (mm) or degrees	12.4 (315) or less, 45 or less	12.3 (490) 70	12.4 (315) or less, 45 or less	12.3 (490) 70
Swing time	Machine position  • Engine : rated speed • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Site : Firm, flat ground • Make one idling turn with no load, then measure the time necessary to make 5 turns.	sec. / 5 turns	27.5	31.5	27.5	31.5
Swing drift	Machine position  • Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Make the boom and bucket pins the same height. • Park the machine on a slope with an inclination of 15 degrees and turn the upperstructure 90 degrees to the track. • Make match marks on the outer race and the inner race of the swing bearing (or the track frame). • Measure shifted distance or angle between both marks after 5 min.	in. (mm)	0	-	0	-

3-2 Engine

1) Nominal and Allowable Values

ViO45-5, ViO55-5

Applicable model				4TNV88-PBV	
Item			Unit	Standard	Wear limit
Cylinder head					
Cylinder head distortion			in. (mm)	0.0020 (0.05) or less	0.0059 (0.15)
Valve seat angle	Intake		degrees (°)	120	–
	Exhaust			90	–
Valve seat width	Intake		in. (mm)	–	
	Exhaust			–	
Intake valve	Stem outside dia.		in. (mm)	0.3132 to 0.3140 (7.955 to 7.975)	0.3110 (7.9)
	Guide inside dia.			0.3154 to 0.3159 (8.010 to 8.025)	0.3189 (8.1)
	Oil clearance			0.0014 to 0.0028 (0.035 to 0.070)	0.0071 (0.18)
Exhaust valve	Stem outside dia.		in. (mm)	0.3132 to 0.3138 (7.955 to 7.970)	0.3110 (7.9)
	Guide inside dia.			0.3155 to 0.3161 (8.015 to 8.030)	0.3189 (8.1)
	Oil clearance			0.0018 to 0.0030 (0.045 to 0.075)	0.0071 (0.18)
Valve guide projection			in. (mm)	0.5787 to 0.5906 (14.7 to 15.0)	–
Valve sinkage	Intake		in. (mm)	0.0118 to 0.0197 (0.30 to 0.50)	0.0315 (0.8)
	Exhaust			0.0118 to 0.0197 (0.30 to 0.50)	
Valve head thickness	Intake		in. (mm)	0.0488 to 0.0567 (1.24 to 1.44)	0.0315 (0.8)
	Exhaust			0.0531 to 0.0610 (1.35 to 1.55)	
Intake valve operating timing	Open	b. TDC	degrees (°)	–	–
	Close	a. BDC		–	–
Exhaust valve operating timing	Open	b. BDC	degrees (°)	–	–
	Close	a. TDC		–	–
Valve spring	Free length		in. (mm)	1.6535 (42.0)	1.6339 (41.5)
	Inclination		in. (mm)	–	0.0551 (1.4)
	Tension [0.0394 in. (1 mm) compressed]		lbs. (kg)	–	–
Intake / exhaust valve clearance			in. (mm)	0.0077 to 0.0081 (0.195 to 0.205)	–
Cylinder block					
Cylinder bore dia.			in. (mm)	3.4646 to 3.4657 (88.000 to 88.030)	3.472 (88.200)
Cylinder bore dia.		L mark		–	
		M mark		–	
		S mark		–	
Roundness of cylinder				0.0004 (0.01) or less	0.0012 (0.03)
Cylindricity of cylinder				0.0004 (0.01) or less	0.0012 (0.03)

Applicable model				4TNV88-PBV	
Item			Unit	Standard	Wear limit
Valve					
	Intake / exhaust valve rocker arm	Shaft outside dia.	in. (mm)	0.6286 to 0.6293 (15.966 to 15.984)	0.6276 (15.94)
		Bush inside dia.		0.6299 to 0.6307 (16.000 to 16.020)	0.6327 (16.07)
		Oil clearance		0.0006 to 0.0021 (0.016 to 0.054)	0.0051 (0.13)
	Push rod bend			–	0.0012 (0.03)
	Tappet	Stem outside dia.		0.4715 to 0.4721 (11.975 to 11.990)	0.4707 (11.955)
		Guide hole inside dia.		0.4724 to 0.4734 (12.000 to 12.025)	0.4742 (12.045)
		Oil clearance		0.0004 to 0.0020 (0.010 to 0.050)	0.0035 (0.090)
Piston					
	Piston outside dia.		in. (mm)	3.4624 to 3.4636 (87.945 to 87.975)	3.4606 (87.900)
	Piston outside dia.	L mark		–	
		ML mark		–	
		MS mark		–	
		S mark		–	
	Minimum clearance between piston and cylinder			0.0016 to 0.0028 (0.040 to 0.070)	–
	Top clearance			0.0268 to 0.0315 (0.68 to 0.80)	–
	Piston pin	Outside dia.		1.0234 to 1.0236 (25.995 to 26.000)	1.0222 (25.965)
		Bush inside dia.		1.0236 to 1.0240 (26.000 to 26.009)	1.0252 (26.039)
		Oil clearance		0 to 0.0006 (0 to 0.014)	0.0029 (0.074)
Piston ring					
	Top ring	Ring groove width	in. (mm)	0.0811 to 0.0817 (2.060 to 2.075)	–
		Ring width		0.0776 to 0.0783 (1.970 to 1.990)	0.0768 (1.950)
		Clearance between groove and ring		0.0028 to 0.0041 (0.070 to 0.105)	–
		End gap		0.00787 to 0.0158 (0.200 to 0.400)	0.0193 (0.490)
	Second ring	Ring groove width		0.0797 to 0.0803 (2.025 to 2.040)	0.0843 (2.140)
		Ring width		0.0776 to 0.0784 (1.970 to 1.990)	0.0768 (1.950)
		Clearance between groove and ring		0.0014 to 0.0028 (0.035 to 0.070)	0.0075 (0.190)
		End gap		0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)

Applicable model				4TNV88-PBV	
Item			Unit	Standard	Wear limit
Piston ring					
	Oil ring	Ring groove width	in. (mm)	0.1581 to 0.1587 (4.015 to 4.030)	0.1626 (4.130)
		Ring width		0.1563 to 0.1571 (3.970 to 3.990)	0.1555 (3.950)
		Clearance between groove and ring		0.0010 to 0.0024 (0.025 to 0.060)	0.0071 (0.180)
		End gap		0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)
Connecting rod					
	Crank pin side	Crank pin metal inside dia.	in. (mm)	1.8898 to 1.8908 (48.000 to 48.026)	–
		Crank pin metal thickness		0.0587 to 0.0591 (1.492 to 1.500)	–
		Crank pin outside dia.		1.8879 to 1.8883 (47.952 to 47.962)	1.8859 (47.902)
		Oil clearance		0.0015 to 0.0029 (0.038 to 0.074)	0.0059 (0.150)
	Piston pin side	Bush inside dia.		1.0246 to 1.0251 (26.025 to 26.038)	1.0263 (26.068)
		Piston pin outside dia.		1.0234 to 1.0236 (25.995 to 26.000)	1.0223 (25.967)
		Oil clearance		0.0010 to 0.0017 (0.025 to 0.043)	0.0040 (0.101)
	Twist and parallelism			0.0012 (0.03) or less for 3.94 (100)	0.0031 (0.08)
Cam					
	Gear side	Bush inside dia.	in. (mm)	1.7713 to 1.7738 (44.990 to 45.055)	1.7768 (45.130)
		Cam shaft outside dia.		1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
		Oil clearance		0.0016 to 0.0051 (0.040 to 0.130)	0.0094 (0.24)
	Intermediate	Bearing inside dia.		1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
		Cam shaft outside dia.		1.7681 to 1.7691 (44.910 to 44.935)	1.7667 (44.875)
		Oil clearance		0.0026 to 0.0045 (0.065 to 0.115)	0.0089 (0.225)
	Flywheel side	Bearing inside dia.		1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
		Cam shaft outside dia.		1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
		Oil clearance		0.0020 to 0.0039 (0.050 to 0.100)	0.0083 (0.210)
	Bend			0.0008 (0.02) or less	0.0020 (0.05)
	Cam height	Intake cam		1.5197 to 1.5276 (38.600 to 38.800)	1.5098 (38.350)
		Exhaust cam		1.5197 to 1.5276 (38.600 to 38.800)	1.5098 (38.350)

Applicable model				4TNV88-PBV	
Item			Unit	Standard	Wear limit
Crank shaft					
	Journal	Outside dia.	in. (mm)	2.1241 to 2.1245 (53.952 to 53.962)	2.1221 (53.902)
		Main metal inside dia.		2.1260 to 2.1268 (54.000 to 54.020)	–
		Main metal thickness		0.0785 to 0.0783 (1.995 to 1.990)	–
		Oil clearance		0.0015 to 0.0027 (0.038 to 0.068)	0.0059 (0.150)
	Bend			–	0.0008 (0.02) or less
Idle gear		Shaft outside dia.	in. (mm)	1.8091 to 1.8100 (45.950 to 45.975)	1.8071 (45.900)
		Bush inside dia.		1.8110 to 1.8120 (46.000 to 46.025)	1.8140 (46.075)
		Oil clearance		0.0010 to 0.0030 (0.025 to 0.075)	0.0069 (0.175)
Trochoid pump		Outside clearance of outer rotor	in. (mm)	0.0047 to 0.0083 (0.12 to 0.21)	0.0118 (0.30)
		Side clearance of outer rotor		0.0008 to 0.0028 (0.02 to 0.07)	0.0047 (0.12)
		Inside clearance of inner rotor		0.0118 to 0.0197 (0.3 to 0.5)	0.0236 (0.6)
		Width across flat clearance of inner rotor		0.0079 to 0.0236 (0.2 to 0.6)	0.0276 (0.7)
Side gap		Crank shaft	in. (mm)	0.0051 to 0.0091 (0.13 to 0.23)	0.0110 (0.28)
		Cam shaft		0.0020 to 0.0079 (0.05 to 0.20)	0.0118 (0.30)
		Connecting rod		0.0079 to 0.0157 (0.20 to 0.40)	–
		Idle gear		–	–
Backlash		Crank gear, Cam gear, Idle gear and Fuel injection pump drive gear	in. (mm)	0.00276 to 0.00591 (0.07 to 0.15)	–
		Lubricating oil pump gear		–	–
Others					
	Lube oil pump discharge volume	High speed	GPM (L/min)	6.6 (25) at 3000 min^{-1} (rpm)	–
		Low speed		2.1 (8) at 800 min^{-1} (rpm)	–
	Oil pressure regulating valve opening pressure		PSI (kPa)	42.66 to 56.88 (294.2 to 392.3)	–
	Oil pressure switch operating pressure		PSI (kPa)	5.69 to 8.53 (39.2 to 58.8)	–
	Cooling water pump discharge volume		GPM (L/min)	9.2 (35) at 3250 min^{-1} (rpm)	–
	Thermostat valve opening temperature	Temperature	°F (°C)	157.1 to 162.5 (69.5 to 72.5)	–
		Lift at opening	in. (mm)	0.315 (8.0) or more at 185°F (85°C) or higher	–
	Thermo-switch operating temperature	ON	°F (°C)	224.6 to 235.4 (107 to 113)	–
		OFF		212 (100) or more	–

ViO45-5B, ViO55-5B

Applicable model				4TNV88-BXBV	
Item			Unit	Standard	Wear limit
Cylinder head					
Cylinder head distortion			in. (mm)	0.0020 (0.05) or less	0.0059 (0.15)
Valve seat angle	Intake		degrees (°)	120	–
	Exhaust			90	–
Valve seat width	Intake		in. (mm)	–	
	Exhaust			–	
Intake valve	Stem outside dia.		in. (mm)	3.4622 to 3.4634 (87.940 to 87.970)	0.3110 (7.9)
	Guide inside dia.			0.3154 to 0.3159 (8.010 to 8.025)	0.3189 (8.1)
	Oil clearance			0.0014 to 0.0028 (0.035 to 0.070)	0.0071 (0.18)
Exhaust valve	Stem outside dia.		in. (mm)	0.3132 to 0.3138 (7.955 to 7.970)	0.3110 (7.9)
	Guide inside dia.			0.3155 to 0.3161 (8.015 to 8.030)	0.3189 (8.1)
	Oil clearance			0.0018 to 0.0030 (0.045 to 0.075)	0.0071 (0.18)
Valve guide projection			in. (mm)	0.5787 to 0.5906 (14.7 to 15.0)	–
Valve sinkage	Intake		in. (mm)	0.0118 to 0.0197 (0.30 to 0.50)	0.0315 (0.8)
	Exhaust			0.0118 to 0.0197 (0.30 to 0.50)	
Valve head thickness	Intake		in. (mm)	0.0488 to 0.0567 (1.24 to 1.44)	0.0315 (0.8)
	Exhaust			0.0531 to 0.0610 (1.35 to 1.55)	
Intake valve operating timing	Open	b. TDC	degrees (°)	–	–
	Close	a. BDC		–	–
Exhaust valve operating timing	Open	b. BDC	degrees (°)	–	–
	Close	a. TDC		–	–
Valve spring	Free length		in. (mm)	1.6535 (42.0)	1.6339 (41.5)
	Inclination		in. (mm)	–	0.0551 (1.4)
	Tension [0.0394 in. (1 mm) compressed]		lbs. (kg)	–	–
Intake / exhaust valve clearance			in. (mm)	0.0077 to 0.0081 (0.195 to 0.205)	–
Cylinder block					
Cylinder bore dia.			in. (mm)	3.4646 to 3.4657 (88.000 to 88.030)	3.472 (88.200)
Cylinder bore dia.		L mark		–	
		M mark		–	
		S mark		–	
Roundness of cylinder				0.0004 (0.01) or less	0.0012 (0.03)
Cylindricity of cylinder				0.0004 (0.01) or less	0.0012 (0.03)

Applicable model				4TNV88-BXBV	
Item			Unit	Standard	Wear limit
Valve					
	Intake / exhaust valve rocker arm	Shaft outside dia.	in. (mm)	0.6286 to 0.6293 (15.966 to 15.984)	0.6276 (15.94)
		Bush inside dia.		0.6299 to 0.6307 (16.000 to 16.020)	0.6327 (16.07)
		Oil clearance		0.0006 to 0.0021 (0.016 to 0.054)	0.0051 (0.13)
	Push rod bend			–	0.0012 (0.03)
	Tappet	Stem outside dia.		0.4715 to 0.4721 (11.975 to 11.990)	0.4707 (11.955)
		Guide hole inside dia.		0.4724 to 0.4734 (12.000 to 12.025)	0.4742 (12.045)
		Oil clearance		0.0004 to 0.0020 (0.010 to 0.050)	0.0035 (0.090)
Piston					
	Piston outside dia.		in. (mm)	3.4622 to 3.4634 (87.940 to 87.970)	3.4606 (87.900)
	Piston outside dia.	L mark		–	
		ML mark		–	
		MS mark		–	
		S mark		–	
	Minimum clearance between piston and cylinder			0.0016 to 0.0028 (0.040 to 0.070)	–
	Top clearance			0.0268 to 0.0315 (0.68 to 0.80)	–
	Piston pin	Outside dia.		1.0234 to 1.0236 (25.995 to 26.000)	1.0222 (25.965)
		Bush inside dia.		1.0236 to 1.0240 (26.000 to 26.009)	1.0252 (26.039)
		Oil clearance		0 to 0.0006 (0 to 0.014)	0.0029 (0.074)
Piston ring					
	Top ring	Ring groove width	in. (mm)	0.0811 to 0.0817 (2.060 to 2.075)	–
		Ring width		0.0776 to 0.0783 (1.970 to 1.990)	0.0768 (1.950)
		Clearance between groove and ring		0.0028 to 0.0041 (0.070 to 0.105)	–
		End gap		0.00787 to 0.0158 (0.200 to 0.400)	0.0193 (0.490)
	Second ring	Ring groove width		0.0797 to 0.0803 (2.025 to 2.040)	0.0843 (2.140)
		Ring width		0.0776 to 0.0784 (1.970 to 1.990)	0.0768 (1.950)
		Clearance between groove and ring		0.0014 to 0.0028 (0.035 to 0.070)	0.0075 (0.190)
		End gap		0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)

Applicable model				4TNV88-BXBV	
Item			Unit	Standard	Wear limit
Piston ring					
	Oil ring	Ring groove width	in. (mm)	0.1581 to 0.1587 (4.015 to 4.030)	0.1626 (4.130)
		Ring width		0.1563 to 0.1571 (3.970 to 3.990)	0.1555 (3.950)
		Clearance between groove and ring		0.0010 to 0.0024 (0.025 to 0.060)	0.0071 (0.180)
		End gap		0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)
Connecting rod					
	Crank pin side	Crank pin metal inside dia.	in. (mm)	1.8898 to 1.8908 (48.000 to 48.026)	–
		Crank pin metal thickness		0.0587 to 0.0591 (1.492 to 1.500)	–
		Crank pin outside dia.		1.8879 to 1.8883 (47.952 to 47.962)	1.8859 (47.902)
		Oil clearance		0.0015 to 0.0029 (0.038 to 0.074)	0.0059 (0.150)
	Piston pin side	Bush inside dia.		1.0246 to 1.0251 (26.025 to 26.038)	1.0263 (26.068)
		Piston pin outside dia.		1.0234 to 1.0236 (25.995 to 26.000)	1.0223 (25.967)
		Oil clearance		0.0010 to 0.0017 (0.025 to 0.043)	0.0040 (0.101)
	Twist and parallelism			0.0012 (0.03) or less for 3.94 (100)	0.0031 (0.08)
Cam					
	Gear side	Bush inside dia.	in. (mm)	1.7713 to 1.7738 (44.990 to 45.055)	1.7768 (45.130)
		Cam shaft outside dia.		1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
		Oil clearance		0.0016 to 0.0051 (0.040 to 0.130)	0.0094 (0.24)
	Intermediate	Bearing inside dia.		1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
		Cam shaft outside dia.		1.7681 to 1.7691 (44.910 to 44.935)	1.7667 (44.875)
		Oil clearance		0.0026 to 0.0045 (0.065 to 0.115)	0.0089 (0.225)
	Flywheel side	Bearing inside dia.		1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
		Cam shaft outside dia.		1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
		Oil clearance		0.0020 to 0.0039 (0.050 to 0.100)	0.0083 (0.210)
	Bend			0.0008 (0.02) or less	0.0020 (0.05)
	Cam height	Intake cam		1.5197 to 1.5276 (38.600 to 38.800)	1.5098 (38.350)
		Exhaust cam		1.5197 to 1.5276 (38.600 to 38.800)	1.5098 (38.350)

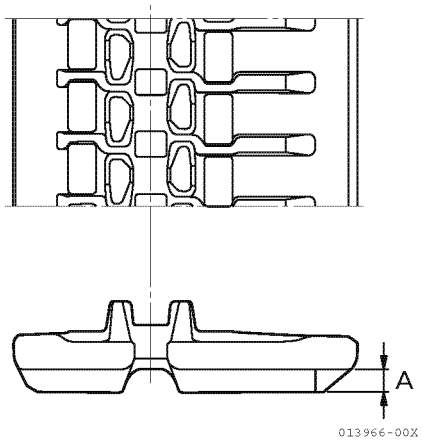
3. SERVICING STANDARDS

Applicable model				4TNV88-BXBV	
Item			Unit	Standard	Wear limit
Crank shaft					
	Journal	Outside dia.	in. (mm)	1.9666 to 1.9670 (49.952 to 49.962)	1.9646 (49.902)
		Main metal inside dia.		1.9685 to 1.9693 (50.000 to 50.020)	–
		Main metal thickness		0.0785 to 0.0791 (1.995 to 2.010)	–
		Oil clearance		0.0015 to 0.0027 (0.038 to 0.068)	0.0059 (0.150)
	Bend			–	0.0008 (0.02) or less
Idle gear		Shaft outside dia.	in. (mm)	1.8091 to 1.8100 (45.950 to 45.975)	1.8071 (45.900)
		Bush inside dia.		1.8110 to 1.8120 (46.000 to 46.025)	1.8140 (46.075)
		Oil clearance		0.0010 to 0.0030 (0.025 to 0.075)	0.0069 (0.175)
Trochoid pump		Outside clearance of outer rotor	in. (mm)	0.0035 to 0.0063 (0.09 to 0.16)	0.0098 (0.25)
		Side clearance of outer rotor		0.0020 to 0.0039 (0.05 to 0.10)	0.0059 (0.15)
		Tip clearance		–	0.0063 (0.16)
		Rotor shaft clearance – Plate bearing I.D.		0.3937 to 0.3943 (10.000 to 10.015)	0.3953 (10.040)
		Rotor shaft clearance – Rotor shaft O.D.		0.3919 to 0.3924 (9.955 to 9.967)	0.3913 (9.940)
		Rotor shaft clearance – Rotor clearance		0.0013 to 0.0024 (0.033 to 0.060)	0.0039 (0.100)
Side gap		Crank shaft	in. (mm)	0.0051 to 0.0091 (0.13 to 0.23)	0.0110 (0.28)
		Cam shaft		0.0020 to 0.0079 (0.05 to 0.20)	0.0118 (0.30)
		Connecting rod		0.0079 to 0.0157 (0.20 to 0.40)	–
		Idle gear		–	–
Backlash		Crank gear, Cam gear, Idle gear and Fuel injection pump drive gear	in. (mm)	0.00276 to 0.00591 (0.07 to 0.15)	–
		Lubricating oil pump gear		–	–
Others					
	Lube oil pump discharge volume	High speed	GPM (L/min)	6.6 (25) at 3000 min^{-1} (rpm)	–
		Low speed		2.1 (8) at 800 min^{-1} (rpm)	–
	Oil pressure regulating valve opening pressure		PSI (kPa)	42.66 to 56.88 (294.2 to 392.3)	–
	Oil pressure switch operating pressure		PSI (kPa)	5.69 to 8.53 (39.2 to 58.8)	–
	Cooling water pump discharge volume		GPM (L/min)	9.2 (35) at 3250 min^{-1} (rpm)	–
	Thermostat valve opening temperature	Temperature	°F (°C)	157.1 to 162.5 (69.5 to 72.5)	–
		Lift at opening	in. (mm)	0.315 (8.0) or more at 185°F (85°C) or higher	–
	Thermo-switch operating temperature	ON	°F (°C)	224.6 to 235.4 (107 to 113)	–
		OFF		212 (100) or more	–

3-3 Undercarriage

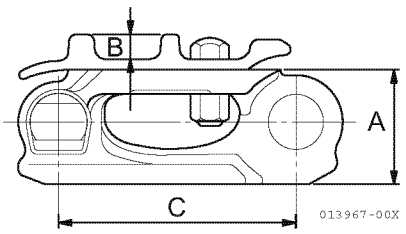
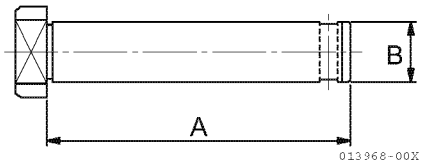
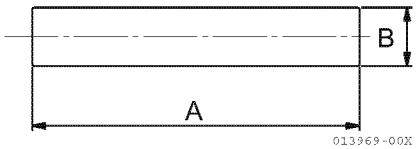
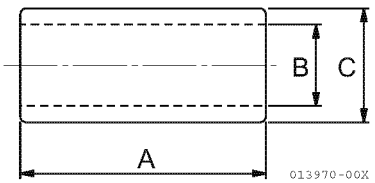
3-3-1 Rubber Track Specifications

[Unit : in. (mm)]

Applicable model	ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Part	Measuring position	Standard	Wear limit
Rubber track specifications			
(1) Rubber track 	A	0.98 (25)	0.39 (10)

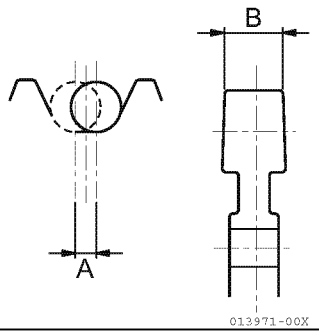
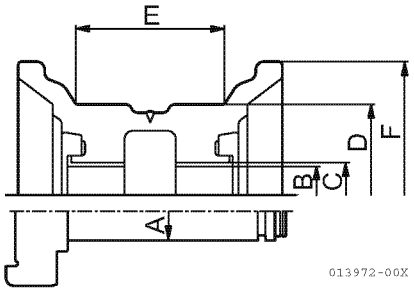
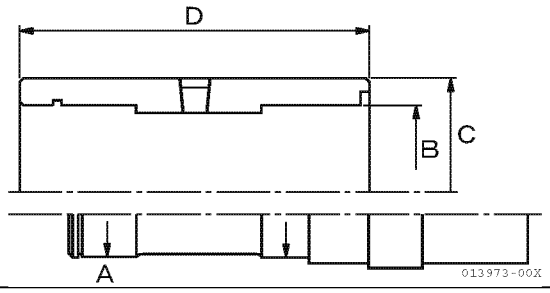
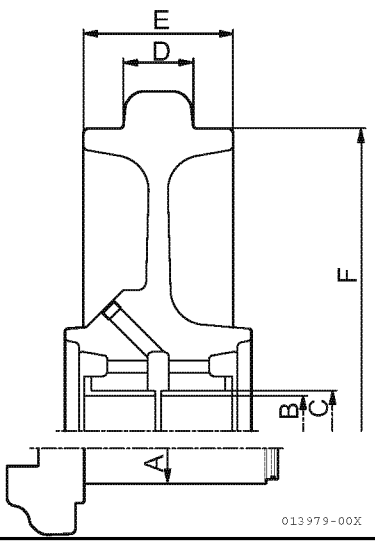
3-3-2 Steel Track Specifications

[Unit : in. (mm)]

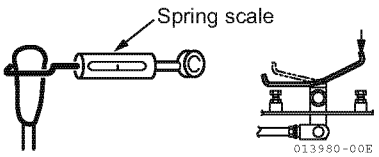
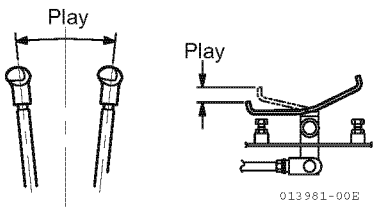
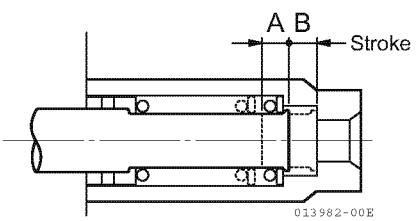
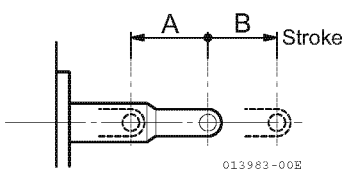
Applicable model	ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Part	Measuring position	Standard	Wear limit
Steel track specifications			
(1) Track link (Triple grouser)  ***Note :*** *For the link pitch, measure 5 links at three places and obtain the*	A	2.64 (67)	2.52 (64)
	B	0.55 (14.0)	0.35 (9.0)
	C	5.32 (135.0)	5.37 (136.5)
(2) Master pin 	A	4.49 (114)	–
	B	Ø0.87 (Ø22.16)	Ø0.77 (Ø19.63)
(3) Pin 	A	4.73 (120.2)	–
	B	Ø0.88 (Ø22.3)	Ø0.79 (Ø20.1)
(4) Bush & master bush 	A	2.89 (73.5)	–
	B	Ø0.89 (Ø22.5)	Ø0.95 (Ø24.1)
	C	Ø1.38 (Ø35)	Ø1.31 (Ø33.2)

3-3-3 Common Specifications of Steel & Rubber Tracks

[Unit : in. (mm)]

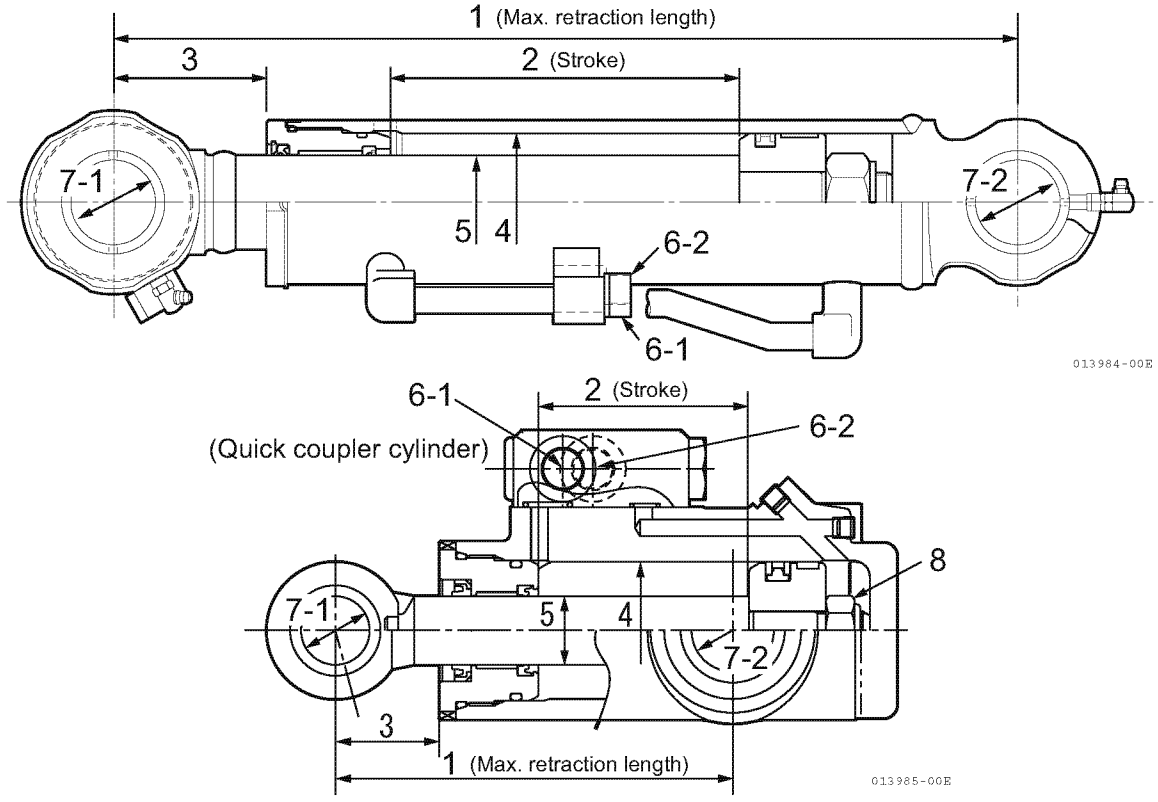
Applicable model		ViO45-5, ViO45-5B ViO55-5, ViO55-5B	
Part	Measuring position	Standard	Wear limit
Common specifications of steel & rubber tracks			
(1) Sprocket 	A	0.20 (5)	0.39 (10)
	B	1.38 (35)	1.14 (29)
(2) Track roller & shaft 	A	Ø1.38 (Ø35)	Ø1.36 (Ø34.5)
	B	Ø1.38 (Ø35)	Ø1.39 (Ø35.4)
	C	Ø1.61 (Ø41)	–
	D	Ø4.33 (Ø110)	Ø4.09 (Ø104)
	E	3.54 (90)	3.78 (96)
	F	Ø6.38 (Ø162)	Ø6.14 (Ø156)
(3) Carrier roller & shaft 	A	Ø1.18 (Ø30)	–
	B	Ø2.44 (Ø62)	–
	C	Ø3.15 (Ø80)	Ø2.99 (Ø76)
	D	4.72 (120)	–
(4) Idler & shaft 	A	Ø1.57 (Ø40)	Ø1.56 (Ø39.5)
	B	Ø1.57 (Ø40)	Ø1.59 (Ø40.4)
	C	Ø1.81 (Ø46)	–
	D	1.50 (38)	1.26 (32)
	E	3.35 (85)	3.15 (80)
	F	Ø13.54 (Ø344)	Ø13.31 (Ø338)

3-4 Controls

Applicable model			ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Item		Measuring conditions	Unit	Standard	Allowable limit
Controls					
Operating force					
	Right control lever (Boom & Bucket)	• Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Lever operating force : Measure the force by hanging the spring scale on the lever grip. • Pedal operating force : Measure the force by applying load as shown below. 	lbs. (kg)	3.09 (1.4)	4.63 (2.1)
	Left control lever (Arm & Swing)			3.09 (1.4)	4.63 (2.1)
	Blade lever			4.41 (2.0)	6.62 (3.0)
	Travel levers			3.31 (1.5)	4.41 (2.0)
				–	–
	Boom swing lever			–	–
	Boom swing pedal			14.33 (6.5)	17.64 (8.0)
	P.T.O. pedal			–	–
Play of control lever & pedal					
	Right control lever (Front & rear / left & right)	• Engine : stopped • Hydraulic oil temp. : 122 to 140 °F (50 to 60 °C) • Play of each control lever and pedal : Measure the total play (front & rear and left & right) at the lever grip end or the pedal end. 	in. (mm)	0.79 (20)	–
	Left control lever (Front & rear / left & right)			0.79 (20)	–
	Blade lever			0.59 (15)	–
	Travel levers			0.79 (20)	–
	Boom swing pedal			0.16 (4)	–
	P.T.O. pedal			–	–
Control valve					
Spool stroke					
	Boom		in. (mm)	0.28 (7.0)	–
	Bucket				
	Arm				
	Swing				
	Blade				
	Parallel-flow divider				
	Inlet				
	Right travel		in. (mm)	0.28 (7.0)	–
	Left travel				
	Boom swing				
	Offset			–	

3-5 Hydraulic Equipment

3-5-1 Hydraulic Cylinders



Unit : in. (mm)

No. / Cylinder	1	2	3	4	5	6-1 / 6-2	7-1 / 7-2		8	
							Standard	Allowable limit	Thread size (mm)	Tightening torque ft•lbf (N•m)
Boom ✱1	40.6 (1031)	26.0 (660)	3.31 (84)	Ø3.74 (Ø95)	Ø1.97 (Ø50)	G3/8	Ø1.97(Ø50)	Ø1.99 (Ø50.5)	M39	1374 to 1447 (1860 to 1960)
Boom ✱2	40.6 (1031)	26.0 (660)	3.31 (84)	Ø3.94 (Ø100)	Ø2.17 (Ø55)	G3/8	Ø1.97(Ø50)	Ø1.99 (Ø50.5)	M39	1374 to 1447 (1860 to 1960)
Arm	45.6 (1159)	29.9 (760)	3.35 (85)	Ø3.35 (Ø85)	Ø1.97 (Ø50)	G3/8 / G1/2	Ø1.97(Ø50)	Ø1.99 (Ø50.5)	M36	1049 to 1121 (1420 to 1520)
Bucket	36.6 (930)	24.8 (630)	3.35 (85)	Ø2.95 (Ø75)	Ø1.97 (Ø50)	G3/8	Ø1.77 (Ø45)	Ø1.79 (Ø45.5)	M33	760 to 833 (1030 to 1130)
Boom swing	33.4 (848)	21.8 (553)	2.95 (75)	Ø3.54 (Ø90)	Ø1.77 (Ø45)	G1/4	Ø1.57 (Ø40)	Ø1.59 (Ø40.5)	M33	1013 to 1085 (1370 to 1470)
Blade	33.5 (850)	8.66 (220)	8.03 (204)	Ø3.54 (Ø90)	Ø1.97 (Ø50)	Rc3/8	Ø1.77 (Ø45)	Ø1.79 (Ø45.5)	M36	1049 to 1121 (1420 to 1520)
Quick coupler	7.40 (188)	3.39 (86)	1.81 (46)	Ø2.56 (Ø65)	Ø1.38 (Ø35)	G1/4	Ø1.38 (Ø35) / Ø1.57 (Ø40)	Ø1.40 (Ø35.5)/ Ø1.59 (Ø40.5)	M20	217 to 253 (294 to 343)

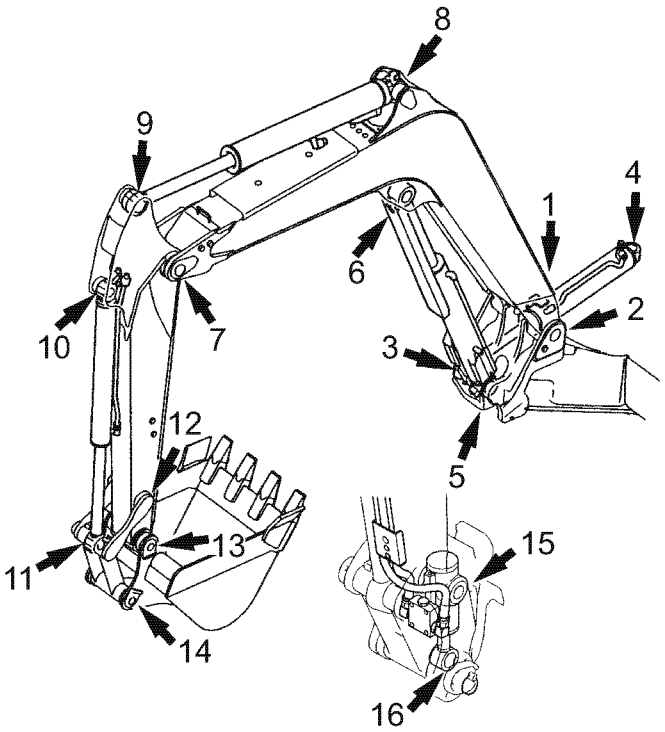
Nut for pipe

Symbol	Name
G (BSPP)	Straight pipe thread
R (BSPT)	Taper pipe thread (male)
Rc (BSPT)	Taper pipe thread (female)

ViO45-5, ViO45-5B : ✱1 : S/N 50501 to 50591, ✱2 : S/N 50592 and after
ViO55-5, ViO55-5B : ✱1 : S/N 50501 to 50800, ✱2 : S/N 50801 and after

3-6 Implement

3-6-1 Front Attachments

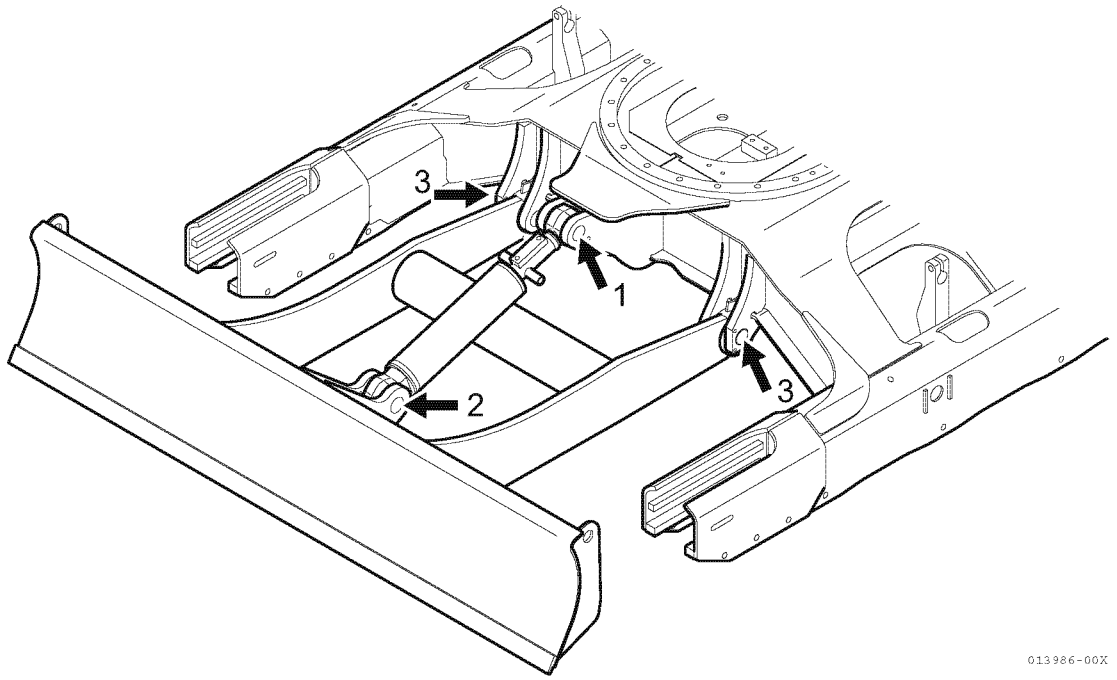


Unit : in. (mm)

No.	Applicable model : ViO45-5, ViO45-5B ViO55-5, ViO55-5B	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Boom swing fulcrum	Ø2.76 (Ø70)	-0.02 (-0.5)	+0.02 (+0.5)
2	Boom fulcrum	Ø2.36 (Ø60)		
3	Boom swing cylinder, rod	Ø1.57 (Ø40)		
4	Boom swing cylinder, bottom	Ø1.57 (Ø40)		
5	Boom cylinder, bottom	Ø1.97 (Ø50)		
6	Boom cylinder, rod	Ø1.97 (Ø50)		
7	Arm fulcrum	Ø2.36 (Ø60)		
8	Arm cylinder, bottom	Ø1.97 (Ø50)		
9	Arm cylinder, rod	Ø1.97 (Ø50)		
10	Bucket cylinder, bottom	Ø1.77 (Ø45)		
11	Bucket cylinder, rod	Ø1.77 (Ø45)		
12	Link “A” arm	Ø1.77 (Ø45)		
13	Bucket fulcrum	Ø1.77 (Ø45)		
14	Bucket “link A”	Ø1.77 (Ø45)		
15	Quick coupler cylinder, bottom	Ø1.57 (Ø40)		
16	Quick coupler cylinder, rod	Ø1.38 (Ø35)		

Note : *Allowable clearance is 0.04 in. (1.0 mm).*

3-6-2 Blade Moving Device



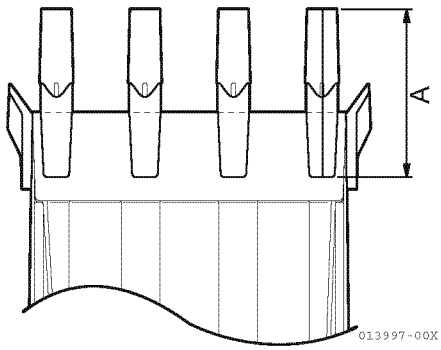
Unit : in. (mm)

No.	Applicable model : ViO45-5, ViO45-5B ViO55-5, ViO55-5B	Standard	Wear limit	
	Measuring point		Pin	Bore of bush or hole
1	Blade cylinder, rod	Ø1.77 (Ø45)	-0.02 (-0.5)	+0.02 (+0.5)
2	Blade cylinder, bottom	Ø1.77 (Ø45)		
3	Blade fulcrum	Ø1.77 (Ø45)		

Note : *Allowable clearance between pin and bore of bush or hole is 0.04 in. (1.0 mm).*

3-6-3 Bucket Teeth

Unit : in. (mm)

Measuring point	Standard	Wear limit	Measure
	9.17 (233.0)	7.05 (179.0)	Replace

3-7 List of Tightening Torque

3-7-1 Machine

Unit : ft•lbf (N•m)

Applicable model:			ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Equipment			Thread size	Tightening torque	Adhesive
	No.	Tightening part			
Engine / Electrical equipment					
	1	Engine mount vibroisolating rubber	M16	155.0 to 170.0 (206 to 235)	Three Bond 1324
	2	Engine × Engine mount (Flywheel side)	M10 (10.9T)	47.0 to 54.3 (63.7 to 73.6)	Three Bond 1324
	3	Engine × Engine mount (Radiator side)	M10 (10.9T)	47.0 to 54.3 (63.7 to 73.6)	Three Bond 1324
	4	Hose clip 70 (Air cleaner intake side)	–	0.9 to 1.1 (1.2 to 1.5)	
	5	Hose clip 70 (Intake hose installation)	–	2.2 to 2.9 (2.5 to 3.4)	
	6	Hose clip (Resonator)	–	1.8 to 2.5 (2.5 to 3.4)	
	7	Fuel gauge hose	Hose band 14	0.7 to 1.1 (1.0 to 1.5)	
	8	Fuel gauge unit	Pan head screw M5	0.9 to 1.1 (1.2 to 1.5)	
	9	Fuel tank	M14	86.8 to 108.5 (118 to 147)	Three Bond 1324
	10	Battery holding rod	Nut M8	2.2 (2.9)	Lock nut 9.4 to 12.3 ft•lbf (12.7 to 16.7 N•m)
	11	CW hose clip 41, 48	–	1.8 to 2.5 (2.5 to 3.4)	
	12	Air cleaner	M8	14.5 to 16.6 (19.6 to 22.6)	
	13	Heater hose	Hose clip 22	1.6 to 1.8 (2.2 to 2.5)	
	14	Drain plug	M14	43.0 (59.0)	
	15	Safety switch (2-speed, cut-off)	Lock nut M18 (Fine)	21.7 to 25.3 (29.4 to 34.3)	
Driving system					
	1	Sprocket	M14	137.4 to 151.9 (186.3 to 205.9)	Loctite 262
Travel device					
	1	Plugs (Idler)	R (PT) 1/8	6.5 to 7.2 (8.8 to 9.8)	Loctite 572
	2	Idler seal cover × Track spring	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324
	3	Track roller tightening nut	Cap nut M16	151.9 to 180.8 (205.9 to 245.2)	Loctite 262
	4	Track guard × Track frame (Steel track spec. only)	M16	123.0 to 151.9 (166.7 to 205.9)	Loctite 262
	5	Track tensioner valve	M16	36.2 (49.0)	

3. SERVICING STANDARDS

Unit : ft•lbf (N•m)

Applicable model:			ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Equipment	No.	Tightening part	Thread size	Tightening torque	Adhesive
Controls					
	1	Blade lever × Pilot valve	M8	12.0 to 13.5 (15.2 to 18.2)	
	2	Grips (L, R) × Levers (L, R)	Binding head screw M4	1.3 to 1.9 (1.8 to 2.5)	Three Bond 1324
Frame					
	1	Swing bearing × Lower frame	M16	195.3 to 224.2 (264.8 to 304.0)	Loctite 262
	2	Swing bearing × Turning frame	M16	195.3 to 224.2 (264.8 to 304.0)	Loctite 262
	3	Counter weight × Turning frame	M24	354.4 to 441.3 (480.5 to 598.2)	Three Bond 1324
Hydraulic equipment					
	1	CF Coupling	Hexagon socket head bolt M12	61.5 to 68.0 (83.4 to 92.2)	Three Bond 1324
	2	Swivel joint × Track frame	M10	32.6 to 43.4 (44.1 to 58.8)	Loctite 262
	3	Swing motor × Turning frame	M16	195.3 to 224.2 (264.8 to 304.0)	Three Bond 1324
	4	Travel motor × Track frame	M14	86.8 to 108.5 (117.7 to 147.1)	Loctite 262
	5	Hydraulic oil tank × Turning frame	M14	86.8 to 108.5 (117.7 to 147.1)	Three Bond 1324
	6	Drain plug 24 × Hydraulic oil tank	M24	78.0 (108.0)	
	7	Oil level gauge × Hydraulic oil tank	M10	10.9 to 11.6 (14.7 to 15.7)	
	8	Hose clip 13	–	1.6 to 1.8 (2.2 to 2.5)	
	9	Hose clip 25	–	2.9 to 3.6 (3.9 to 4.9)	
	10	Hose clip 60, 70	–	3.6 to 4.3 (4.9 to 5.9)	
Rigging					
	1	Canopy pole × Canopy mount A (canopy type)	M16 (10.9T)	123.0 to 151.9 (166.7 to 205.9)	Three Bond 1324
	2	Canopy comp. × Frame (canopy type)	M12 (10.9T)	58.0 to 72.0 (78.4 to 98.0)	Three Bond 1324
	3	Track frame × Motor cover	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
	4	Track frame × Under cover	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324

3. SERVICING STANDARDS

Unit : ft•lbf (N•m)

Applicable model:			ViO45-5, ViO45-5B ViO55-5, ViO55-5B		
Equipment			Thread size	Tightening torque	Adhesive
	No.	Tightening part			
Implements					
	1	Side cutter × Bucket	M16	191.7 to 217.0 (259.9 to 294.2)	Loctite 262
	2	Lock plate (Boom bracket fulcrum pin)	M14	86.8 to 108.5 (117.7 to 147.1)	Three Bond 1324
	3	Lock plate (Arm fulcrum pin)	M14	86.8 to 108.5 (117.7 to 147.1)	Three Bond 1324
	4	Lock plate (Boom cylinder rod end pin)	M14	86.8 to 108.5 (117.7 to 147.1)	Three Bond 1324
	5	Lock plate (Boom swing cylinder rod end pin)	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324
	6	Lock plate (Boom swing cylinder bottom end pin)	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
	7	Lock plate (Arm cylinder bottom end pin)	M14	86.8 to 108.5 (117.7 to 147.1)	Three Bond 1324
	8	Lock plate (Arm cylinder rod end pin)	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324
	9	Lock plate (Bucket cylinder bottom end pin)	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324
	10	Lock plate (Blade fulcrum pin)	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
	11	Lock plate (Blade cylinder pin)	M12	57.9 to 72.3 (78.5 to 98.1)	Three Bond 1324
	12	Protector × Cylinder	M10	32.6 to 43.4 (44.1 to 58.8)	Three Bond 1324
	13	Protector × Cylinder	M10 (10.9T)	47.0 to 54.0 (63.7 to 73.5)	Three Bond 1324

3-7-2 Engine

Tightening torque for major bolts and nuts

No.	Item	Thread size × Pitch	Tightening torque Unit : ft•lbf (N•m)	Lubricating oil
1	Cylinder head bolt	M10 × 1.25	62.9 to 67.3 (85.3 to 91.1)	Yes
2	Connecting rod bolt	M9 × 1.0	32.6 to 36.2 (44.1 to 49.0)	Yes
3	Flywheel mounting bolt	M10 × 1.25	61.5 to 65.1 (83.3 to 88.2)	Yes
4	Metal cap mounting bolt	M12 × 1.5	68.7 to 76.0 (93.2 to 98.0)	Yes
5	Crankshaft pulley fastening bolt	M14 × 1.5	83.2 to 90.4 (112.7 to 122.7)	Yes
6	Fuel injection valve tap bolt	M8 × 1.25	18.1 to 21.0 (24.4 to 28.4)	No
7	Fuel injection pump gear nut	M14 × 1.5	57.9 to 65.1 (78 to 88)	No
8	Fuel injection pipe fastening nut	M12 × 1.5	21.7 to 25.3 (29.4 to 34.3)	No

3-7-3 Tightening Torque for General Bolts and Nuts

Item		Thread size × Pitch	Tightening torque [Unit : ft•lbf (N•m)]	Remarks
Hexagon head bolt (7T) Nut	Coarse thread	M6 × 1	7.23 to 8.68 (9.8 to 11.8)	1) Apply 80% of tightening torque when tightened to aluminum. 2) Apply 60% of tightening torque for 4T bolts and lock nuts. 3) Use fine screw threads for engine only.
		M8 × 1.25	16.6 to 21.0 (22.5 to 28.4)	
		M10 × 1.5	32.6 to 43.4 (44.1 to 58.8)	
		M12 × 1.75	57.9 to 72.3 (78.4 to 98.0)	
		M14 × 2	86.8 to 108.5 (117.6 to 147.0)	
		M16 × 2	123.0 to 151.9 (166.6 to 205.8)	
		M18 × 2.5	173.6 to 209.8 (235.2 to 284.2)	
		M20 × 2.5	238.7 to 296.6 (323.4 to 401.8)	
	Fine thread	M14 × 1.5	94.0 to 108.5 (127.4 to 147.0)	
		M16 × 1.5	155.5 to 177.2 (210.7 to 240.1)	
PT plug		1/8	7.23 (9.8)	
		1/4	14.5 (19.6)	
		3/8	21.7 (29.4)	
		1/2	43.4 (58.8)	
Pipe joint bolt		M8	9.4 to 12.3 (12.7 to 16.7)	
		M12	18.1 to 25.3 (24.5 to 34.3)	
		M14	28.9 to 36.2 (39.2 to 49.0)	
		M16	36.2 to 43.4 (49.0 to 58.8)	

CHAPTER 4

ENGINE

4-1 General 4-1-1
4-1-1 How to Read This Manual 4-1-1
4-1-2 Precautions for Service Work 4-1-3
4-1-3 Engine External Views 4-1-4
4-1-4 Structural Description 4-1-4
4-1-5 Exhaust Gas Emission Regulation 4-1-5
4-2 Troubleshooting 4-2-1
4-2-1 Quick Reference Table for Troubleshooting 4-2-1
4-2-2 Troubleshooting by Measuring Compression Pressure 4-2-4
4-3 Inspection and Adjustment 4-3-1
4-3-1 Oil Inspection 4-3-1
4-3-2 Cooling Water Inspection 4-3-1
4-3-3 Inspecting Water Leak from Cooling Water System and Radiator 4-3-1
4-3-4 Fan Belt Tension Inspection and Adjustment 4-3-2
4-3-5 Adjusting the Valve Clearance 4-3-3
4-3-6 Inspecting the Fuel Injection Valve Injection Pressure and Spray Pattern 4-3-5
4-3-7 Fuel Injection Timing Adjustment / Fuel Injection Pump Inspection and Adjustment 4-3-9
4-3-8 Sensor Inspection 4-3-12
4-3-9 Battery Inspection 4-3-13
4-3-10 Adjusting Operation 4-3-15
4-3-11 Long Storage 4-3-16
4-3-12 Periodic Maintenance Schedule 4-3-17
4-4 Engine Body 4-4-1
4-4-1 Introduction 4-4-1
4-4-2 Cylinder Head 4-4-2
4-4-3 Gear Train and Camshaft 4-4-11
4-4-4 Cylinder Block 4-4-16
4-5 Lubrication System 4-5-1
4-5-1 Lubrication System Diagram 4-5-1
4-5-2 Trochoid Pump (ViO45-5, ViO55-5: 4TNV88-PBV) 4-5-1
4-5-3 Trochoid pump (ViO45-5B, ViO55-5B: 4TNV88-BXBV) 4-5-3
4-6 Cooling System 4-6-1
4-6-1 Cooling Water System 4-6-1
4-6-2 Cooling Water Pump Components 4-6-1
4-6-3 Disassembly (Reverse the Procedure Below for Assembly) 4-6-2
4-6-4 Servicing Points 4-6-2
4-7 Fuel Injection Pump / Governor 4-7-1
4-7-1 Introduction 4-7-1
4-7-2 Fuel Injection Pump 4-7-1
4-8 Electrical Equipment 4-8-1
4-8-1 Starter Motor 4-8-1
4-8-2 Alternator 4-8-3
4-8-3 Air Heater 4-8-6

4. Engine

4-1 General

4-1-1 How to Read This Manual

1) Range of Operation Explanation

This manual explains the troubleshooting, installation / removal, replacement, disassemble / reassembly, inspection, adjustment and adjusting operation procedures for the 4TNV88-PBV engine.

Refer to the manufacturer's manual for each of the fuel injection pump, governor, starting motor and alternator except for their installation.

2) How to Read the Explanations

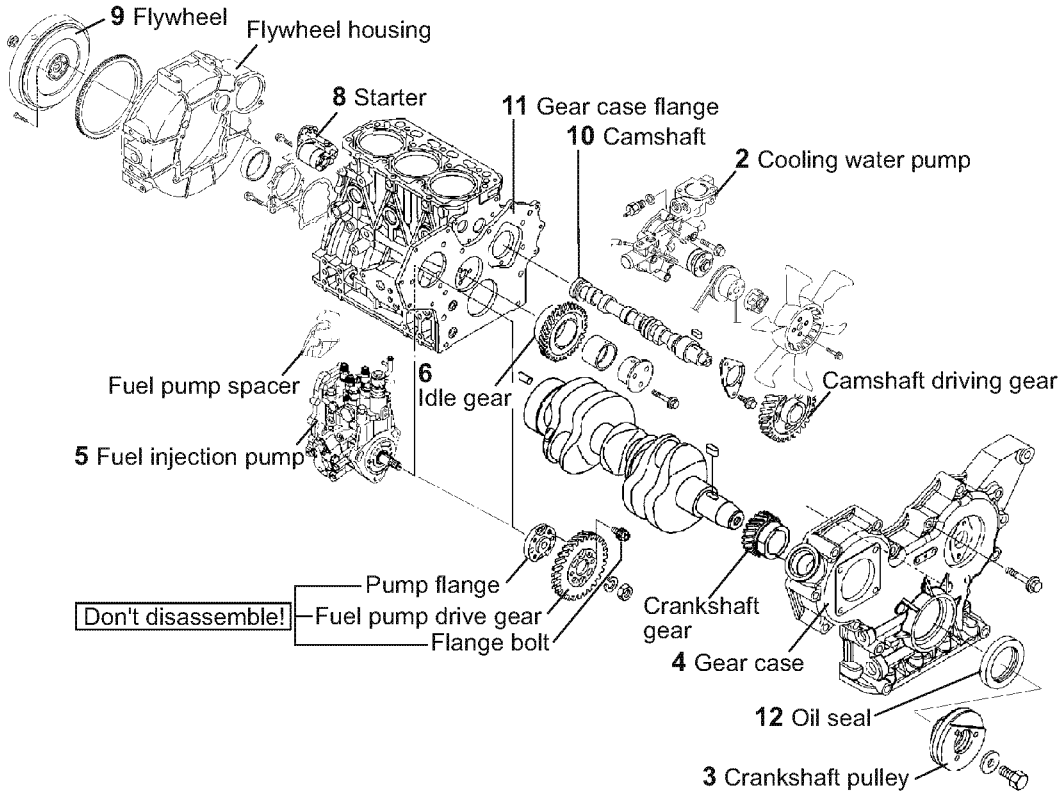
(1) An exploded view, sectional views, a system diagram, etc. are shown at the beginning of each section as required for easy understanding of the mounted states of the components.

(2) For the removal/installation of each part, the procedure is shown with the procedural step No. in the illustration.

(3) Precautions and key points for disassembly and reassembly of parts are described as points. In the explanation for each point, detailed operation method, information, standard and precautions are described.

Description example

- **Illustration**



- **Disassembly procedure**

1 Follow steps 1 to 15 of the cylinder head disassembly procedure.

2 Remove the cooling water pump.

3 Remove the crankshaft pulley. ***(Point 1)***→Operation point to be explained on a later page.

- **Operation points**

Disassemble : Service point for removal

Reassemble : Service point for installation

Disassemble-Reassemble : Service point required in both removal and installation

• **Contents omitted in this manual**

Though the following jobs are omitted in the explanation in this manual, they should be conducted in actual work:

(1) Jacking up and lifting
(2) Cleaning and washing of removed parts as required
(3) Visual inspection

3) Definition of Terms

Notice : Instruction which negligence is very likely to cause an accident. Always observe it.

Standard : Allowable range for inspection and adjustment.

Limit : The maximum or minimum value that must be satisfied during inspection or adjustment.

4) Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
Ass'y	Assembly	T.D.C.	Top dead center
Sub-Ass'y	Sub-assembly	B.D.C	Bottom dead center
a.T.D.C.	After top dead center	OS	Oversize
b.T.D.C.	Before top dead center	US	Undersize
STD	Standard	RPM	Revolutions per minute
IN	Intake	HP (kW)	Output
Ex	Exhaust	T	Bolt/nut tightening torque

4-1-2 Precautions for Service Work

1) Precautions for Safety

Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

2) Preparation for Service Work

Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.

(1) Preceding service date
(2) Period/operation hours after preceding service
(3) Problems and actions in preceding service
(4) Replacement parts expected to be required for service
(5) Recording form/check sheet required for service

3) Preparation before Disassembly

(1) Prepare general tools, special service tools, measuring instruments, oil, grease, non-reusable parts, and parts expected to be required for replacement.
(2) When disassembling complicated portions, put matchmarks and other marks at places not adversely affecting the function for easy reassembly.

4) Precautions in Disassembly

(1) Each time a parts is removed, check the part installed state, deformation, damage, roughening, surface defect, etc.
(2) Arrange the removed parts orderly with clear distinction between those to be replaced and those to be used again.
(3) Parts to be used again shall be washed and cleaned sufficiently.
(4) Select especially clean locations and use clean tools for disassembly of hydraulic units such as the fuel injection pump.

5) Precautions for Inspection and Measurement

(1) Inspect and measure parts to be used again as required to determine whether they are reusable or not.

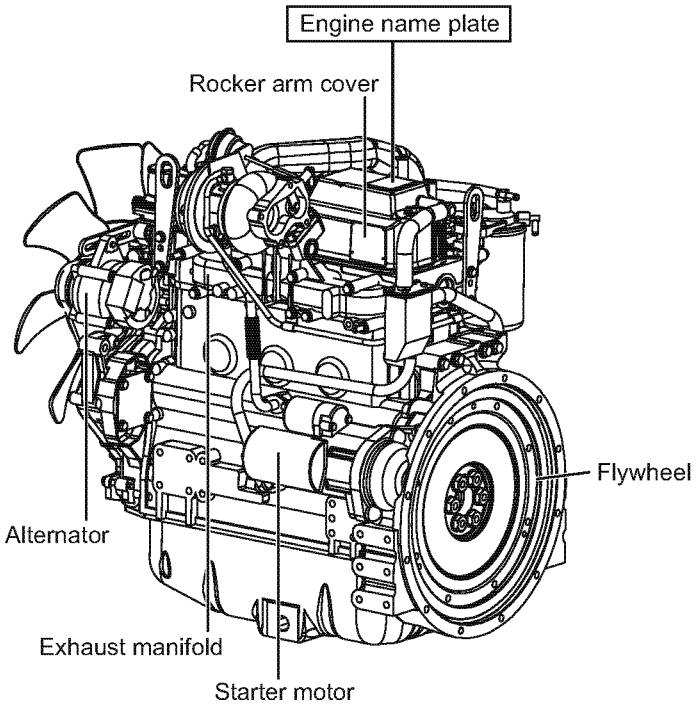
6) Precautions for Reassembly

(1) Reassemble correct parts in correct order according to the specified standards (tightening torques, and adjustment standards). Apply oil to important bolts and nuts before tightening when specified.
(2) Always use genuine parts for replacement.
(3) Always use new oil seals, O-rings, packings and cotter pins.
(4) Apply sealant to packings depending on the place where they are used. Apply oil or grease to sliding contact portions, and apply grease to oil seal lips.

7) Precautions for Adjustment and Check

(1) Use measuring instruments for adjustment to the specified service standards.

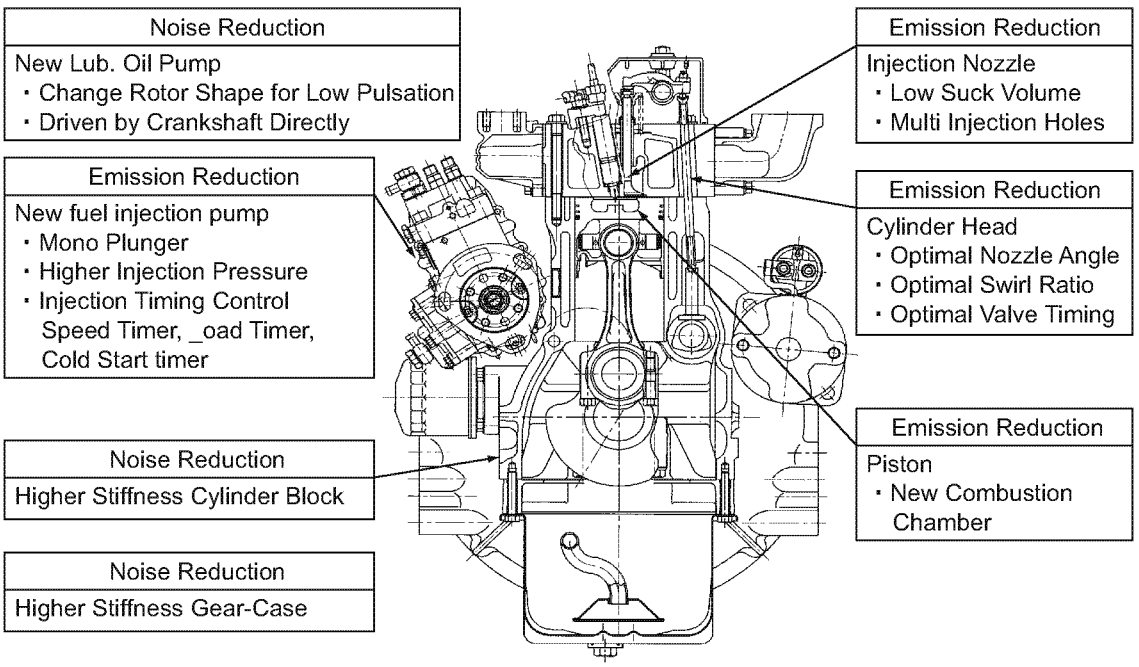
4-1-3 Engine External Views



Note :

This illustration does not show the 4TNV88 engine.

4-1-4 Structural Description



4-1-5 Exhaust Gas Emission Regulation

The engines in this manual have been certified by the US EPA, California ARB and/or the 97/68/EC Directive.

California

Proposition 65 Warning

Diesel engine exhaust and some of its constitutions are known to the State of California to cause cancer, birth defects, and other reproductive harm.

California

Proposition 65 Warning

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.

1) The Emission Standard in USA

(1) EPA Nonroad Diesel Engine Emission Standards

g/kW•hr (g/bhp•hr)

Engine Power	Tier	Model Year	NOx	HC	NMHC + NOx	CO	PM
kW < 8 (hp < 11)	Tier 1	2000	-	-	10.5 (7.8)	8.0 (6.0)	1.0 (0.75)
	Tier 2	2005	-	-	7.5 (5.6)	8.0 (6.0)	0.80 (0.60)
8 <= kW < 19 (11 <= hp < 25)	Tier 1	2000	-	-	9.5 (7.1)	6.6 (4.9)	0.80 (0.60)
	Tier 2	2005	-	-	7.5 (5.6)	6.6 (4.9)	0.80 (0.60)
19<= kW < 37 (25 <= hp < 50)	Tier 1	1999	-	-	9.5 (7.1)	5.5 (4.1)	0.80 (0.60)
	Tier 2	2004	-	-	7.5 (5.6)	5.5 (4.1)	0.60 (0.45)
37 <= kW < 75 (50 <= hp < 100)	Tier 1	1998	9.2 (6.9)	-	-	-	-
	Tier 2	2004	-	-	7.5 (5.6)	5.0 (3.7)	0.40 (0.30)
	Tier 3	2008	-	-	4.7 (3.5)	5.0 (3.7)	
75 <= kW < 130 (100 <= hp < 175)	Tier 1	1997	9.2 (6.9)	-	-	-	-
	Tier 2	2003	-	-	6.6 (4.9)	5.0 (3.7)	0.30 (0.22)
	Tier 3	2007	-	-	4.0 (3.0)	5.0 (3.7)	

Notes :

- *The EPA emission regulation under 130 kW is mentioned below.*
- *As for Model year, the year which a regulation is applicable to is shown.*

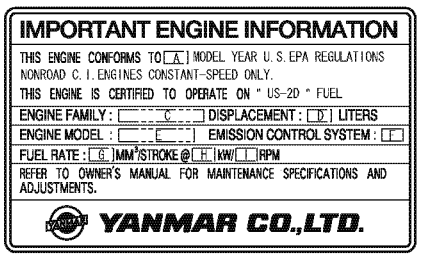
Engine classification	Transient smoke standards % opacity (acceleration/lug/peak modes)
Constant speed engine	Not regulated
Variable speed engine	20/15/50 or less

(2) California ARB Emission Regulation

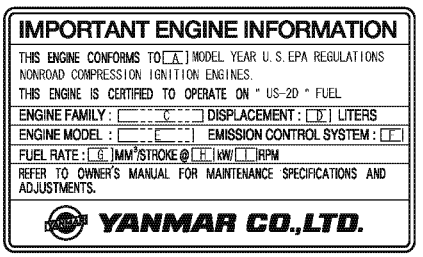
The ARB emission standard is based on that of the EPA.

2) Engine Identification

(1) Emission control labels of US EPA

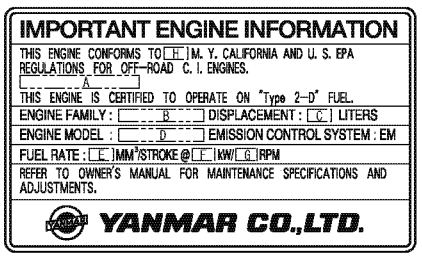

IMPORTANT ENGINE INFORMATION
THIS ENGINE CONFORMS TO [A] MODEL YEAR U. S. EPA REGULATIONS NONROAD C. I. ENGINES CONSTANT-SPEED ONLY.
THIS ENGINE IS CERTIFIED TO OPERATE ON " US-2D " FUEL
ENGINE FAMILY : [C] DISPLACEMENT : [D] LITERS
ENGINE MODEL : [E] EMISSION CONTROL SYSTEM : [F]
FUEL RATE : [G] MM³/STROKE @ [H] kW/[I] RPM
REFER TO OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.
YANMAR CO.,LTD.

EPA label for constant speed engines

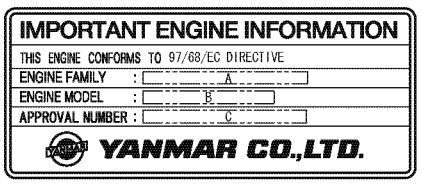

IMPORTANT ENGINE INFORMATION
THIS ENGINE CONFORMS TO [A] MODEL YEAR U. S. EPA REGULATIONS NONROAD COMPRESSION IGNITION ENGINES.
THIS ENGINE IS CERTIFIED TO OPERATE ON " US-2D " FUEL
ENGINE FAMILY : [C] DISPLACEMENT : [D] LITERS
ENGINE MODEL : [E] EMISSION CONTROL SYSTEM : [F]
FUEL RATE : [G] MM³/STROKE @ [H] kW/[I] RPM
REFER TO OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.
YANMAR CO.,LTD.

EPA label for variable speed engines

(2) Emission control label for both EPA and ARB


IMPORTANT ENGINE INFORMATION
THIS ENGINE CONFORMS TO [H] M. Y. CALIFORNIA AND U. S. EPA REGULATIONS FOR OFF-ROAD C. I. ENGINES.
[A]
THIS ENGINE IS CERTIFIED TO OPERATE ON "Type 2-D" FUEL.
ENGINE FAMILY : [B] DISPLACEMENT : [C] LITERS
ENGINE MODEL : [D] EMISSION CONTROL SYSTEM : EM
FUEL RATE : [E] MM³/STROKE @ [F] kW/[G] RPM
REFER TO OWNER'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.
YANMAR CO.,LTD.

(3) 97/68EC Directive label



3) Guarantee Conditions for the EPA Emission Standard

The following guarantee conditions are set down in the operation manual. In addition to making sure that these conditions are met, check for any deterioration that may occur before the required periodic maintenance times.

(1) Requirement on engine installation condition

(a)Intake air depression

kPa (mmAq)

Initial	Permissible
<= 2.94 (300)	<= 6.23 (635)

(b)Exhaust gas back pressure

kPa (mmAq)

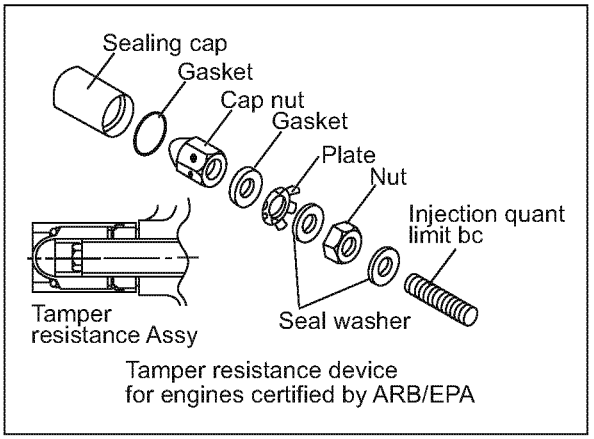
Engine type	Initial	Permissible
Naturally aspirated engines	<= 12.75 (1300)	<= 15.30 (1560)

(2) Fuel oil and lubricating oil

(a)Fuel : The diesel fuel oil US No.2 diesel fuel oil.

(b)Lube oil : API grade, class CD or CF

(3) Do not remove the seals restricting injection quantity and engine speed.



Tamper resistance device for engines certified by ARB/EPA

(4) Perform maintenance without fail.

Note :

Inspections to be carried out by the user and by the maker are divided and set down in the "List of Periodic Inspections" and should be checked carefully.

(5) Maintenance period and Quality guarantee period for exhaust emission related parts

The maintenance of the parts related to the exhaust emission must be carried out in the maintenance period as shown in the below table.

A guarantee period is that either the operation hours or years shown in the table come first in the condition that the maintenance inspection was carried out based on the "List of Periodic Inspections".

	Maintenance period		Quality Guarantee Period
Parts / Power Rating	•Fuel nozzle cleaning	Adjustment, cleaning, repairs for fuel nozzle, fuel pump, turbocharger, electronic control unit etc.	For nozzle, fuel pump, turbocharger
37 <= kW < 130	Every 1500 hours (applied from Tier 2)	Every 3000 hours (applied from Tier 2)	3000 hours / 5 years
19 <= kW < 37 except constant speed engines >= 3000 min^{-1}	Every 1500 hours	Every 3000 hours	3000 hours / 5 years
KW < 19 And constant speed engines beyond 3000 min^{-1} under 37 kW	Every 1500 hours	Every 3000 hours	1500 hours / 2 years

4. ENGINE

4-2 Troubleshooting

4-2-1 Quick Reference Table for Troubleshooting

The following table summarizes the general trouble symptoms and their causes. If ant trouble symptom occurs, take corrective action before it develops into a serious problem so as not to shorten the engine service life.

Cause \ Trouble symptom		Starting failure				Insufficient engine output			Poor exhaust color		High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting		Large engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Lubricating oil				Much blow-by gas	Cooling water		Air intake		Exhaust temperature rise		Corrective action
			Engine starts but stops soon			Exhaust color			During work																						
		Engine does not start	Exhaust smoke: None	Exhaust smoke: Little	Exhaust smoke: Much	Ordinary	White	Black	White	Black				During idling	During work				Excessive consumption	Dilution by fuel oil	Mixture with water	Low L.O. pressure		Overheat	Low water temperature	Pressure drop	Pressure rise			
Engine system	Improper clearance of intake/exhaust valve	○	○			○						○														○		○		Adjust the valve clearance.
	Compression leakage from valve seat					○		○		○		○						○					○			○		○		Lap the valve seat.
	Seizure of intake/exhaust valve	○			○	○		○		○		○			○	○				○			○			○				Correct or replace.
	Blowout from cylinder head gasket					○															○			○						Replace the gasket.
	Seized or broken piston ring	○			○		○		○			○		○		○			○	○			○	○				○		Replace the piston ring.
	Worn piston ring, piston or cylinder	○			○		○		○										○	○			○							Perform honing and use oversize parts.
	Seized crankpin metal or bearing	○	○									○		○	○	○							○							Repair the replace.
	Improper arrangement of piston ring joints		○				○												○				○							Correct the ring joint positions.
	Reverse assembly of piston rings						○		○										○				○							Reassemble correctly.
	Worn crankpin and journal bearing					○						○		○	○	○						○								Measure and replace.
	Loosened connecting rod bolt											○				○						○								Tighten to the specified torque.
	Foreign matter trapped in combustion chamber	○										○							○				○							Disassemble and repair.
	Excessive gear backlash											○																		Adjust gear meshing.
	Worn intake/exhaust valve guide						○												○				○							Measure and replace.
	Defective governor		○											○	○	○	○													Make adjustment.
	Improper open/close timing of intake/exhaust valves	○					○	○	○	○		○																		Adjust the valve clearance.

	Trouble symptom / Cause	Starting failure: Engine does not start	Starting failure: Engine starts but stops soon – Exhaust smoke: None	Starting failure: Engine starts but stops soon – Exhaust smoke: Little	Starting failure: Engine starts but stops soon – Exhaust smoke: Much	Insufficient engine output – Exhaust color: Ordinary	Insufficient engine output – Exhaust color: White	Insufficient engine output – Exhaust color: Black	Poor exhaust color – During work: White	Poor exhaust color – During work: Black	High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting: During idling	Hunting: During work	Large engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Lubricating oil: Excessive consumption	Lubricating oil: Dilution by fuel oil	Lubricating oil: Mixture with water	Lubricating oil: Low L.O. pressure	Much blow-by gas	Cooling water: Overheat	Cooling water: Low water temperature	Air intake: Pressure drop	Air intake: Pressure rise	Exhaust temperature rise		Corrective action
Cooling water system	Excessive cooling effect of radiator								○									○												Defective thermostat (kept closed).
	Insufficient cooling effect of radiator							○																○				○		Defective thermostat (kept closed) or slipping fan belt.
	Insufficient cooling water level							○																○				○		Check water leakage from cooling water system.
	Cracked water jacket																			○	○			○						Repair or replace.
	Slackened fan belt							○																○				○		Adjust the belt tension.
	Defective thermostat							○	○															○	○					Check or replace.
Lubricating system	Improper properties of lubricating oil	○	○			○												○			○	○							Use proper lubricating oil.
	Leakage from lubricating oil piping system																	○			○								Repair.
	Insufficient delivery capacity of trochoid pump																				○								Check or repair.
	Clogged lubricating oil filter																				○	○							Clean or replace.
	Defective pressure regulating valve																				○								Clean, adjust or replace.
	Insufficient lubricating oil level		○																		○								Add proper lubricating oil.
Fuel system	Too early timing of fuel injection pump								○	○	○					○													Check and adjust.
	Too late timing of fuel injection pump						○	○	○	○								○										○		Check and adjust.
	Improper properties of fuel oil					○	○	○	○	○			○																	Use proper fuel oil.
	Water entrance in fuel system	○			○		○		○				○	○	○															Perform draining from the fuel filter.
	Clogged fuel filter	○	○			○																								Clean or replace.
	Air entrance in fuel system	○	○			○																								Perform air bleeding.
	Clogged or cracked fuel pipe	○	○			○																								Clean or replace.
	Insufficient fuel supply to fuel injection pump	○	○			○																								Check the fuel tank cock, fuel filter, fuel pipe, and fuel feed pump.
	Uneven injection volume of fuel injection pump						○	○	○	○			○	○	○	○												○		Check and adjust.
	Excessive fuel injection volume									○								○	○				○	○			○	○		Check and adjust.
	Poor spray pattern from fuel injection nozzle						○	○	○	○			○	○	○	○		○												Check and adjust.
	Priming failure	○																												Foreign matter trapped in the valve inside the priming pump. (Disassemble and clean.)
	Clogged strainer at feed pump inlet					○																								Clean the strainer.

	Trouble symptom / Cause	Starting failure: Engine does not start	Starting failure: Engine starts but stops soon – Exhaust smoke: None	Starting failure: Engine starts but stops soon – Exhaust smoke: Little	Starting failure: Engine starts but stops soon – Exhaust smoke: Much	Insufficient engine output – Exhaust color: Ordinary	Insufficient engine output – Exhaust color: White	Insufficient engine output – Exhaust color: Black	Poor exhaust color – During work: White	Poor exhaust color – During work: Black	High knocking sound during combustion	Abnormal engine sound	Uneven combustion sound	Hunting: During idling	Hunting: During work	Large engine vibration	Difficulty in returning to low speed	Excessive fuel consumption	Lubricating oil: Excessive consumption	Lubricating oil: Dilution by fuel oil	Lubricating oil: Mixture with water	Lubricating oil: Low L.O. pressure	Much blow-by gas	Cooling water: Overheat	Cooling water: Low water temperature	Air intake: Pressure drop	Air intake: Pressure rise	Exhaust temperature rise		Corrective action
Air/exhaust gas system	Clogged air filter				○			○		○			○																	Clean.
	Engine used at high temperatures or at high altitude							○		○								○							○					Study output drop and load matching.
	Clogged exhaust pipe							○		○			○															○		Clean.
Electrical system	Starting motor defect	○																												Repair or replace.
	Alternator defect	○																												Repair or replace.
	Open-circuit in wiring	○																												Repair.
	Battery voltage drop	○																												Inspect and charge the battery.

4-2-2 Troubleshooting by Measuring Compression Pressure

Compression pressure drop is one of major causes of increasing blow by gas (lubricating oil contamination or increased lubricating oil consumption as a resultant phenomenon) or starting failure. The compression pressure is affected by the following factors :

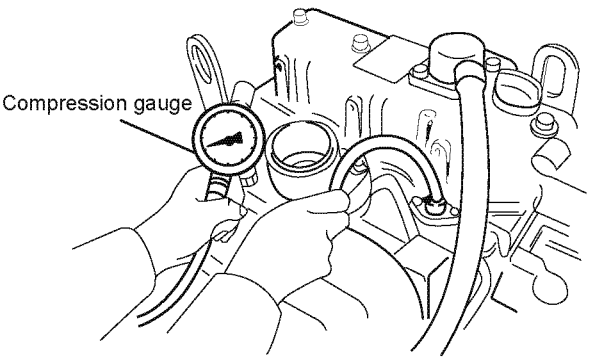
(1) Degree of clearance between piston and cylinder
(2) Degree of clearance at intake/exhaust valve seat
(3) Gas leak from nozzle gasket or cylinder head gasket

In other words, the pressure drops due to increased parts wear and reduced durability resulting from long use of the engine.

A pressure drop may also be caused by scratched cylinder or piston by dust entrance from the dirty air cleaner element or worn or broken piston ring. Measure the compression pressure to diagnose presence of any abnormality in the engine.

1) Compression Pressure Measurement Method

(1) After warming up the engine, remove the fuel injection pump and valves from the cylinder to be measured.
(2) Crank the engine before installing the compression gage adapter.
[1] Perform cranking with the regulator handle at the stop position (no injection state).
[2] For compression gage and compression gage adapter, refer to Section "4-10 Special Service Tools".
(3) Install the compression gage and compression gage adapter at the cylinder to be measured.
*Never forget to install a gasket at the tip end of the adapter.
(4) With the engine set to the same state as in 2 *1, crank the engine by the starting motor until the compression gage reading is stabilized.



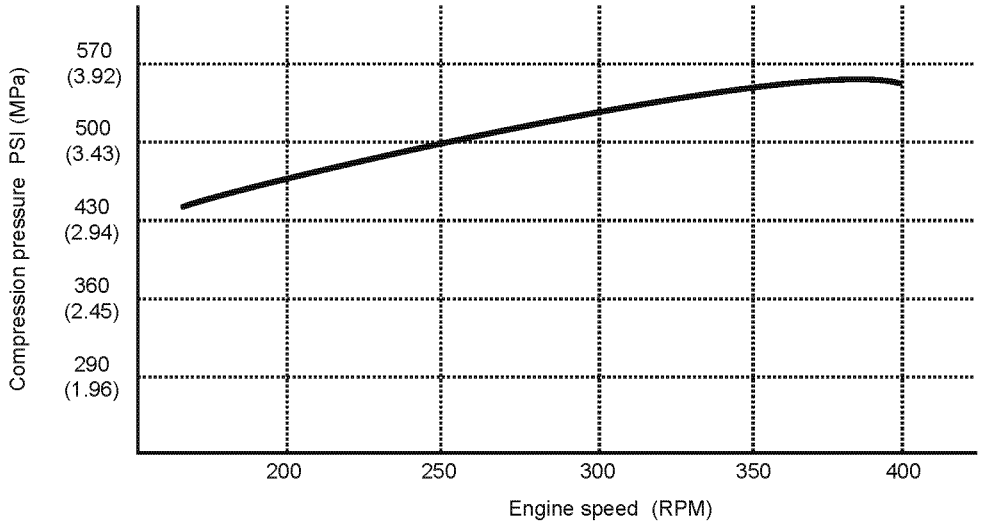
Measuring the compression pressure

2) Standard Compression Pressure

[Engine compression pressure list (reference value)]

Compression pressure (PSI (MPa)) at 250 RPM		Dispersion among cylinders (PSI (MPa))
Standard	Limit	
485 to 515 (3.33 to 3.53)	385 (2.65)	28 to 43 (0.2 to 0.3)

3) Engine Speed and Compression Pressure (Reference)



4) Measured Value and Troubleshooting

When the measured compression pressure is below the limit value, inspect each part by referring to the table below.

No.	Item	Cause	Corrective action
1	• Air cleaner	• Clogged element • Broken element • Defect at element seal portion	• Clean the element. • Replace the element.
2	• Valve clearance	• Excessive or no clearance	• Adjust the valve clearance.
3	• Valve timing	• Incorrect valve clearance	• Adjust the valve clearance.
4	• Cylinder head gasket	• Gas leak from gasket	• Replace the gasket. • Retighten the cylinder head bolts to the specified torque.
5	• Intake/exhaust valve • Valve seat	• Gas leak due to worn valve seat or foreign matter trapping • Sticking valve	• Lap the valve seat. • Replace the intake/exhaust valve.
6	• Piston • Piston ring • Cylinder	• Gas leak due to scratching or wear	• Perform honing and use an over-sized part.

4-3 Inspection and Adjustment

4-3-1 Oil Inspection

• Standard

The level shall be between the upper and lower limit lines on the dipstick.

Total volume	ViO45-5 ViO45-5B	ViO55-5 ViO55-5B
	9.4 Qts. (8.9 L)	

(1) The oil shall not be contaminated heavily and have appropriate viscosity. No cooling water or diesel gas oil shall be mixed.
(2) Insert the dipstick fully and check the oil level.

Notice :

The oil should not be overfilled to exceed the upper limit line.

Otherwise, oil may jet out from the breather or the engine may become faulty.

4-3-2 Cooling Water Inspection

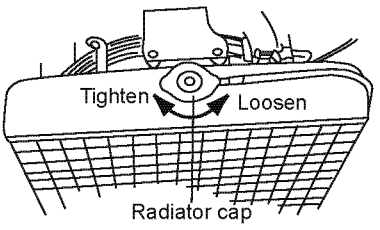
• Standard

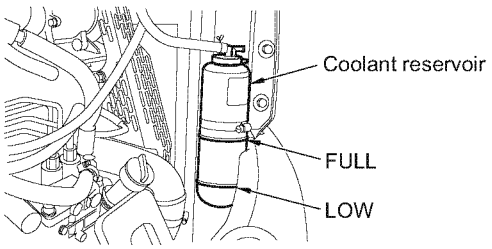
Engine : The radiator shall be filled up.

Sub-tank : The water level shall be between the upper and lower limit lines.

Capacity	Engine	6.66 Qts. (6.3 L)
	Coolant reservoir	0.42 Qts. (0.4 L)

(1) The cooling water shall be checked when the engine is cold.
(2) If the water level is normal in the sub-tank but low in the radiator, check loosened clamping of the rubber hose between the radiator and coolant reservoir or tear in the hose.

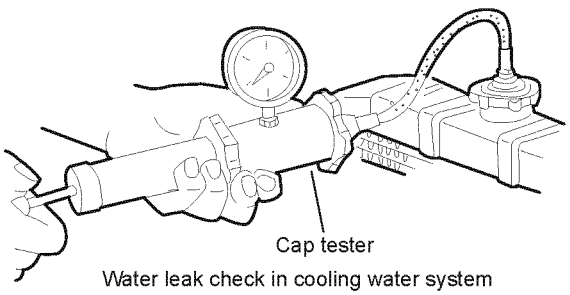




4-3-3 Inspecting Water Leak from Cooling Water System and Radiator

1) Water Leak Check in Cooling Water System

(1) Fill cooling water to the normal level in the radiator, and install the cap tester on the radiator.
(2) Operate the manual pump to set the pressure to 10.7 to 14.9 PSI (73.6 to 103.0 kPa). If the cap tester pressure gage reading drops then, water is leaking from the cooling water system. Check the water leaking point.

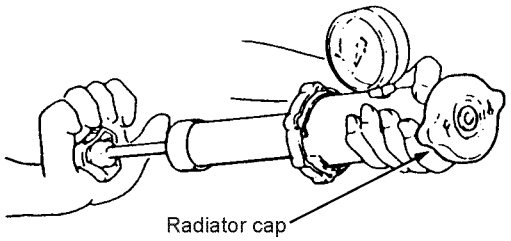


Water leak check in cooling water system

2) Radiator Cap Inspection

Install the radiator cap on the cap tester. Set the tester pressure to 10.7 to 14.9 PSI (73.6 to 103.0 kPa) and see that the cap is opened.

If the cap does not open, replace the cap since it is abnormal.

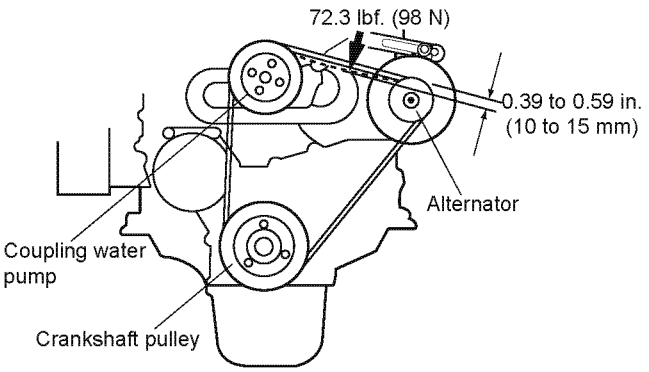


Radiator cap inspection

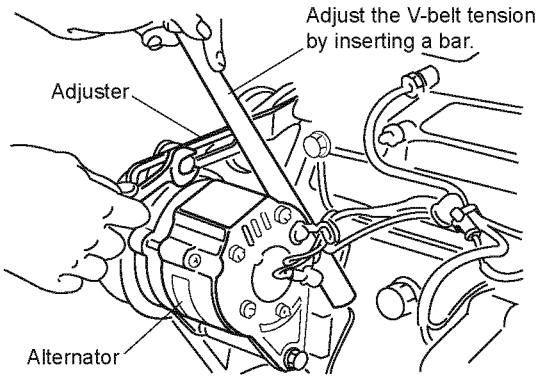
4-3-4 Fan Belt Tension Inspection and Adjustment

Standard : 0.39 to 0.59 in. (10 to 15 mm)/ 72.3 lbf. (98 N)

Push the center of the V belt between the alternator and cooling water with a finger. The V belt tension is normal if the deflection is 0.39 to 0.59 in. (10 to 15 mm). If not, adjust the V belt tension by the alternator adjuster.



V-belt tension



Tension adjustment

4-3-5 Adjusting the Valve Clearance

Standard : 0.006 to 0.01 in. (0.15 to 0.25 mm)

Make measurement and adjustment while the engine is cold.

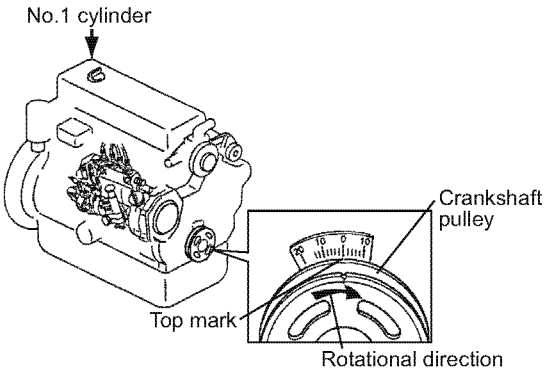
(a)Valve clearance measurement

[1] Remove the rocker arm cover above cylinder head.

[2] Set the No.1 cylinder in the compression TDC

Turn the crankshaft to bring the piston of the No.1 cylinder to its compression top dead center while watching the rocker arm motion, timing scale and the top mark position of the crankshaft pulley.

(Position where both the intake and exhaust valves are closed.)



Top mark

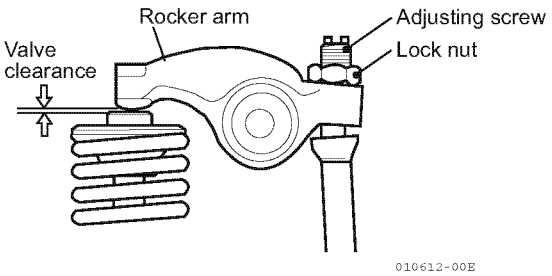
Notes :

- *The crankshaft shall be turned clockwise as seen from the radiator side.*
- *The No.1 cylinder position is on the opposite side of the radiator and the ignition order shall be 1-3-4-2-1 at 180° intervals.*
- *Since the intake and exhaust valve rocker arms are operated the same and there is a clearance between the arm and valve generally at the top dead center, the position can be checked by means of the play when the arm head is held with a hand. Also see that the crankshaft pulley top mark is positioned at zero on the timing scale. If there is no valve clearance, inspection in the disassembled state is necessary since the valve seat may be worn abnormally.*

[3] Valve clearance measurement

Insert a thickness gage between the rocker arm and the valve cap, and record the measured valve clearance.

(Use it as the data for estimating the wear state.)



[4] Adjusting other cylinders

Turn the crankshaft 180° and make adjustment for the No.3 cylinder. Then adjust the No.4 and No.2 cylinders in this order.

The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 180° each time.

The adjustment method of reducing the flywheel turning numbers (for reference):
Set No.1 cylinder to the compression T.D.C. and adjust the clearance of the ● mark of the below table. Next, turn the flywheel once, and adjust the clearance of the ○ mark.

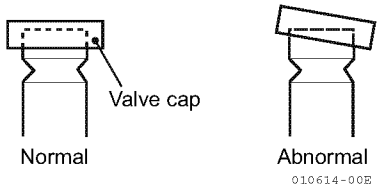
Ignition order of 3 cylinder engines: 1→3→4→2

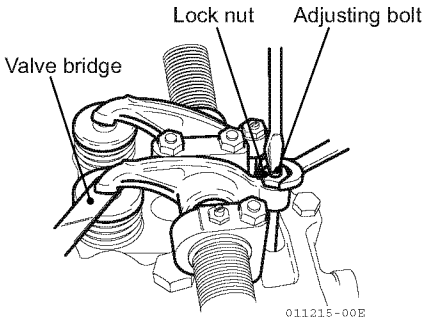
Cylinder No.	1		2		3		4		
Valve	Suction	Exhaust	Suction	Exhaust	Suction	Exhaust	Suction	Exhaust	
No.1 compression T.D.C	●	●	●			●			The first time
No.4 compression T.D.C				○	○		○	○	The second time

(b)Valve clearance inspection and adjustment

[1] Loosen adjusting bolts

Loosen the lock nut and adjusting screw. Check the valve for any inclination of valve cap, dirt or wear.





[2] Measuring valve clearance
Insert a 0.008 or 0.012 in. (0.2 or 0.3 mm) thickness gage between the rocker arm and valve cap and adjust the valve clearance. Tighten the adjusting screw.

Standard valve clearance :
0.006 to 0.01 in. (0.15 to 0.25 mm)

[3] Apply oil to the contact surface between adjusting screw and push rod.
[4] Adjusting other cylinders
Turn the crankshaft 180° then and make adjustment for the No.3 cylinder. Then adjust the No.4 and No.2 cylinders in this order.
The cylinder to be adjusted first does not have to be the No.1 cylinder. Select and adjust the cylinder where the piston is the nearest to the top dead center after turning, and make adjustment for other cylinders in the order of ignition by turning the crankshaft 180° each time.

4-3-6 Inspecting the Fuel Injection Valve Injection Pressure and Spray Pattern

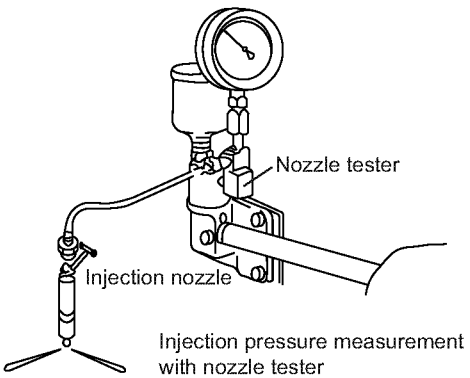
⚠ CAUTION

Wear protective glasses when testing injection from the fuel injection valve. Never approach the injection nozzle portion with a hand. The oil jetting out from the nozzle is at a high pressure to cause loss of sight or injury if coming into careless contact with it.

1) Injection Pressure Measurement
Standard : 2850 to 2950 PSI (19.6 to 20.6 MPa)

*Remove carbon deposit at the nozzle hole thoroughly before

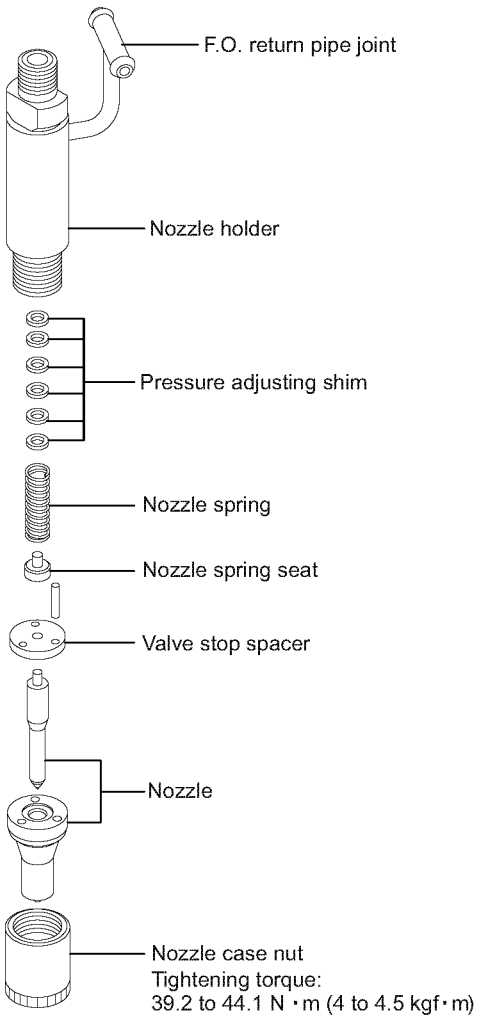
[1] Connect the fuel injection valve to the high pressure pipe of the nozzle tester.
[2] Operate the nozzle tester lever slowly and read the pressure at the moment when the fuel injection from the nozzle starts.
[3] If the measured injection pressure is lower than the standard level, replace the pressure adjusting shim with a thicker one.



Injection pressure measurement with nozzle tester

Type of pressure adjusting shim thickness in. (mm)	Injection pressure adjustment
0.0051 (0.13) 0.0059 (0.15) 0.0071 (0.18) 0.0157 (0.4) 0.0197 (0.5) 0.0315 (0.8)	The injection pressure is increased by approx. 270 PSI (1863 kPa) when the adjusting shim thickness is increased by 0.0039 in. (0.1 mm)

[Reference : Fuel injection valve structure]



2) Spray Pattern Inspection

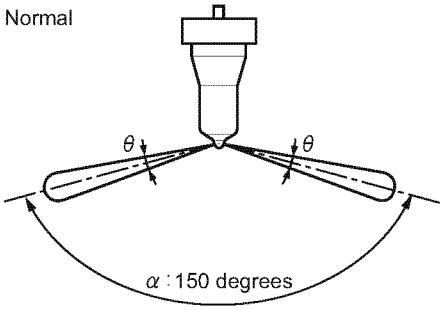
After adjustment to the specified valve opening pressure, use a nozzle tester and check the spray pattern and seat oil-tightness.

(1) Seat oil-tightness check

- After injecting a few times, increase the pressure gradually. Hold the pressure for about 5 seconds at a little before the valve opening pressure of 284 PSI (1961 kPa), and check to see that oil does not drip from the tip end of the nozzle.
- If extreme oil leak from the overflow joint exists during injection by the nozzle tester, check after retightening. If much oil is leaking, replace the nozzle assembly.

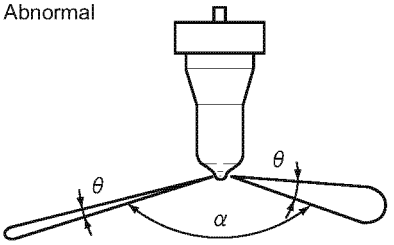
(2) Spray and injection states

- Operate the nozzle tester lever at a rate of once or twice a second and check no abnormal injection.
- If normal injection as shown below cannot be obtained, replace the fuel injection valve.
  - •No extreme difference in angle (θ)
  - •No extreme injection angle difference (α)
  - •Finely atomized spray
  - •Excellent spray departure



Uniform spray pattern from each nozzle

010630-00E

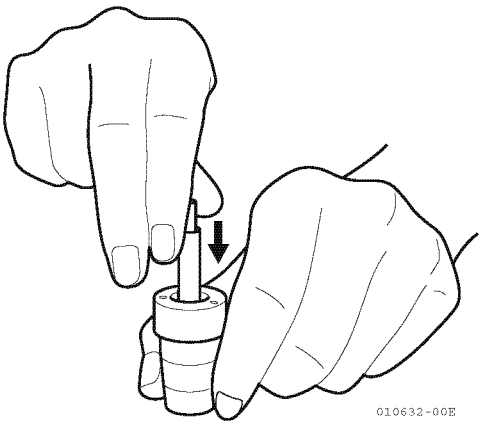


Extreme difference in angle (θ)
Extremely different injection angle (α)
Non-atomized spray
Stagnant spray

010631-00E

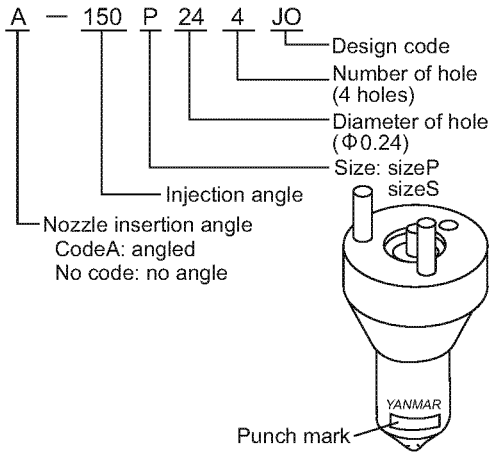
3) Nozzle Valve Sliding Test

Wash the nozzle valve in clean fuel oil. Place the nozzle body vertically and insert the nozzle into the body to about 1/3 of its length. The valve is normal if it smoothly falls by its own weight into the body. In case of a new nozzle, remove the seal peel, and immerse it in clean diesel oil or the like to clean the inner and outer surfaces and to thoroughly remove rust-preventive oil before using the nozzle. Note that a new nozzle is coated with rust-preventive oil and is pasted with the seal peel to shut off outer air.



Nozzle valve sliding check by gravity

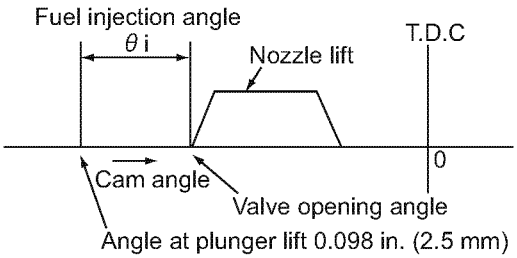
4) Nozzle Punch Mark



4-3-7 Fuel Injection Timing Adjustment / Fuel Injection Pump Inspection and Adjustment

The fuel injection timing and the fuel injection pump are adjusted so that engine performance may become the best condition. As for the inspection and adjustment of the fuel pump, it is based on the service manual of the MP pump of the separate volume. The fuel injection timing is adjusted by the following procedure.

As for the engine, which adopts a MP type fuel injection pump, the fuel injection angle θ_i (note) is adjusted for the fuel injection timing adjustment, because the adjusting method of fuel injection timing like an inline fuel pump can't be applied.



Fuel injection angle

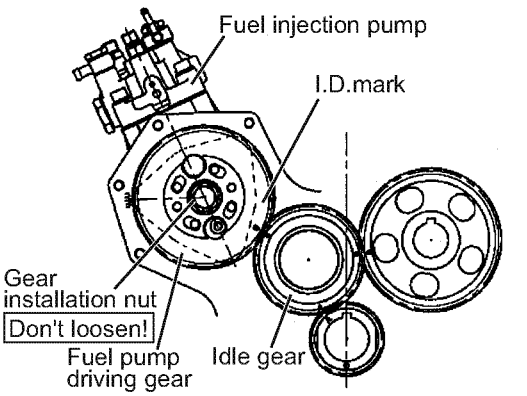
Note :

The fuel injection angle θ_i (cam angle) is the difference from the injection valve opening angle while the fuel injection pump being driven by a motor and the angle at the plunger lift 0.098 in. (2.5 mm) of the fuel pump.

And, as for the actual fuel injection angle θ_i , the measured value is recorded on the pump body by each every fuel pump.

The adjustment of fuel injection angle θ_i

In case that a fuel pump cover, installed with a gear case cover and the fuel pump are removed, and reassembled, the procedure of fuel injection angle adjustment is as follows.



Fuel pump installation angle

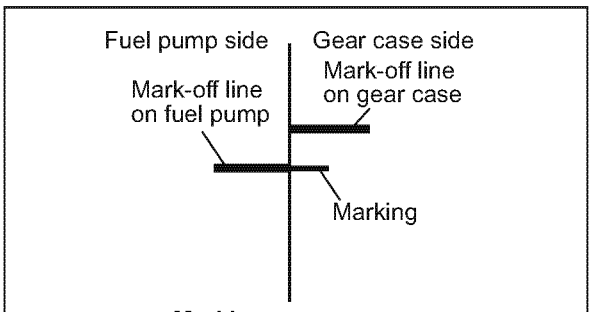
Notice :

Never loosen four flange bolts, which fasten a pump flange and a fuel pump drive gear at the time of the removal of the fuel pump. When it is loosened, the adjustment of the fuel injection timing becomes very difficult.

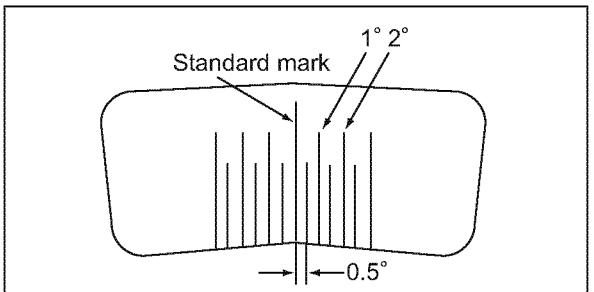
[1] Before removing a fuel pump drive gear, make ID marks on the gearing part of the pump drive gear and the idle gear with paint and so on.

[2] Make the mark-off line to the gear case precisely in accordance with the position of mark-off line of the fuel pump.

[3] Before removing a fuel pump, put the standard mark of a sticker for fuel injection angle adjustment in accordance with the mark-off line of the fuel pump and paste it on the gear case.

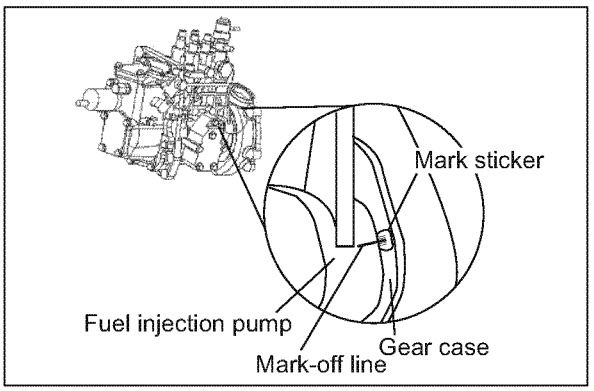


Marking on gear case



Sticker for adjusting injection angle

[4] Remove a fuel pump, and read the fuel injection angle recorded in that fuel pump.



[5] Read the injection angle recorded on a reassembled fuel pump and calculate the difference from the injection angle of the disassembled fuel pump. (When re-installation does the same fuel pump, the angular difference is zero.)

Fuel injection angle difference (cam angle) = (the fuel injection angle of a reassembled fuel pump)
- (the fuel injection angle of a disassembled previous fuel pump)

Notice :

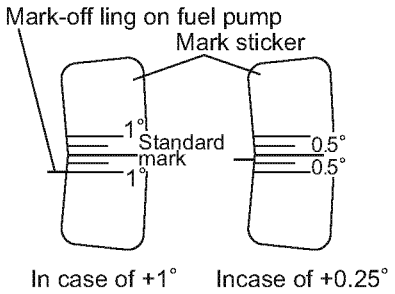
Tell the fuel pump number to Yanmar, and inquire the injection angle of the pump when it is hard to find out.

[6] Put the fuel pump on the gear case temporarily and install the drive gear on the cam shaft with checking the ID marks, which were put on the fuel pump drive gear and the idle gear at the time of the disassembling.

Tighten the installation nut of a pump drive gear.

Tightening torque ft•lbf (N•m)	Lubricating oil application (thread portion, and seat surface)
58 to 65 (78 to 88)	Not applied

[7] Adjust the injection angle difference, calculated in the above 5), at 0.25° in the unit in the installation angle of the fuel pump while reading the mark (minimum 0.5° and cam angle) of the adjustment sticker.



Injection angle adjustment

Notice :

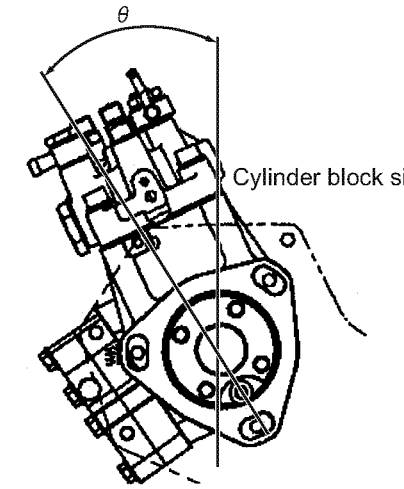
Push down the fuel pump in the outside direction of the cylinder block at +1 degree when a injection angle difference is +1 degree. And, push it down to the cylinder block side when a difference is –1 degree.

[8] Tighten the fuel pump installation nuts.

(Supplementary explanation 1)

The installation angle of the fuel pump is as follows.

Model	Installation angle θ (deg.)
4TNV88	25



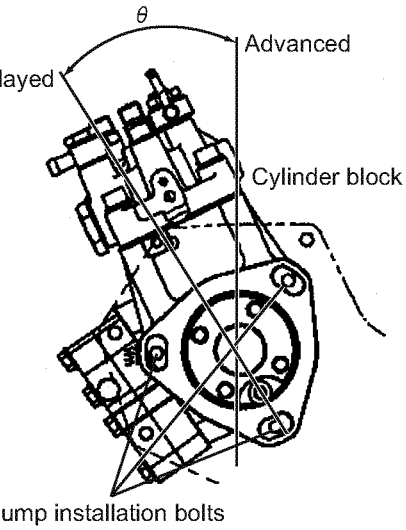
Fuel pump installation angle

(Supplementary explanation 2)

When fuel injection timing is advanced or delayed, the installation angle of the fuel pump is adjusted.

When fuel injection timing is advanced for example at 2 degrees, loosen the nuts, which fix the fuel pump on the gear case, and turn the fuel pump body in the outside direction of the cylinder block at 1 degree, and tighten the pump installation nuts.

And, when fuel injection timing is delayed, a pump is turned in that reverse direction.



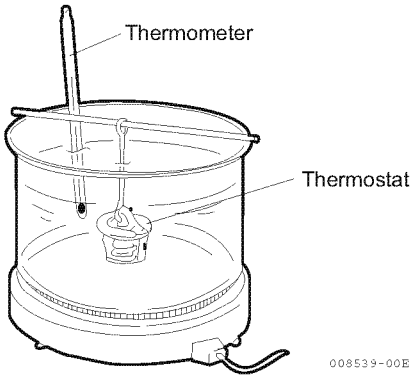
Injection timing adjustment

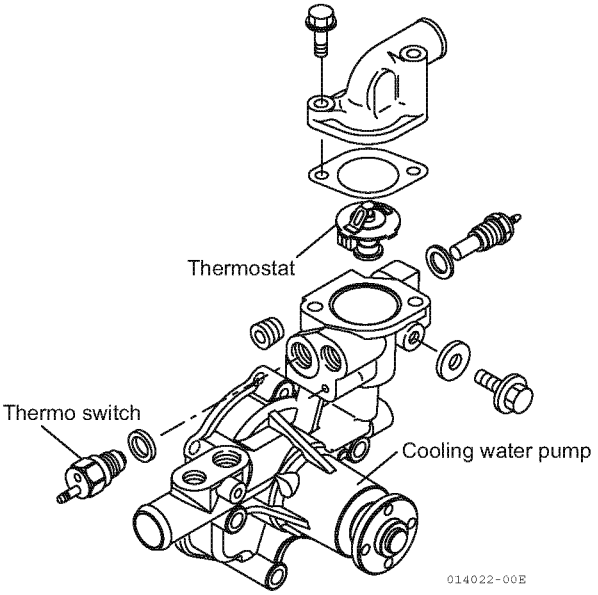
4-3-8 Sensor Inspection

1) Thermostat and Thermal Switch Inspection

(1) Thermostat

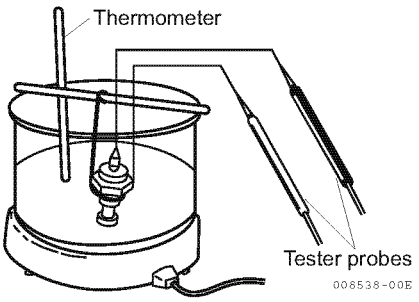
Place the thermostat in a container filled with water. Heat it while measuring the water temperature, and see that the thermostat is actuated at 157.1 to 162.5 °F (69.5 to 72.5 °C).





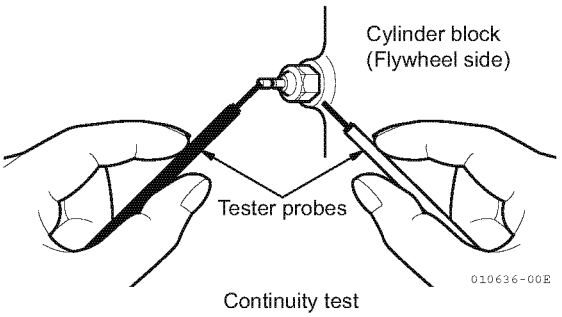
(2) Thermo switch

Place the thermo switch in a container filled with anti-freeze or oil. Heat it while measuring the fluid temperature. The switch is normal if the voltammeter shows continuity when the fluid temperature is 224.6 to 235.4°F (107 to 113°C)



2) Oil Pressure Switch

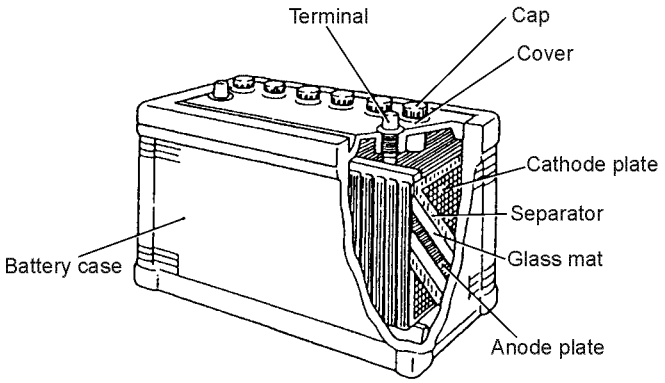
Disconnect the connector from the oil pressure switch. Keep the voltammeter probes in contact with the switch terminal and cylinder block while operating the engine. It is abnormal if circuit is closed.



Continuity test

4-3-9 Battery Inspection

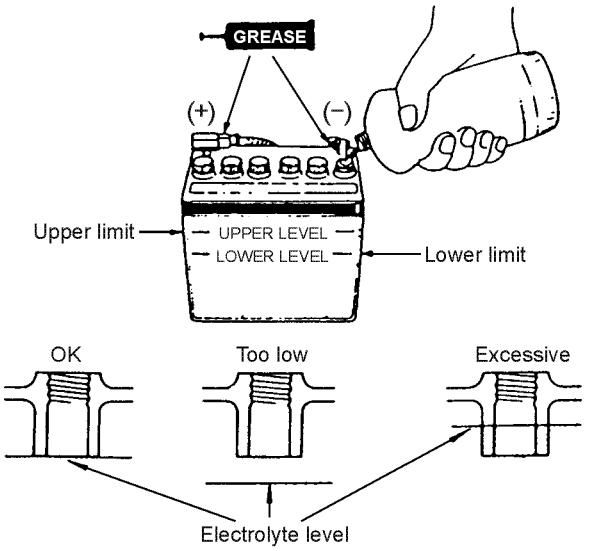
1) Battery Structure



2) Battery Inspection

(1) Electrolyte level

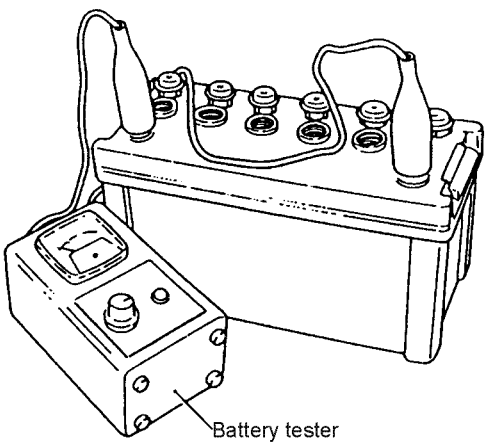
Add distilled water to the upper limit if the level is low.



(2) Battery charge

Use a battery tester or hydrometer and check the battery condition. If the battery is discharged, recharge it.

- Measurement with a battery tester
  When checking the battery with the batter tester, connect the red clip of the tester to the battery positive (+) terminal and black clip to the battery negative (–) terminal by pinching them securely, and judge the battery charge level from the indicator position.
  Green zone : Normal
  Yellow zone : Slightly discharged
  Red zone : Defective or much discharged



Battery charge measurement with battery tester

• Measurement with hydrometer
When using a hydrometer, the measured specific gravity must be corrected according to the temperature at the time of measurement. The specific gravity of battery electrolyte is defined with 68°F (20°C) as the standard. Since the specific gravity increases or decreases by 0.0007 when the temperature varies by 33.8°F (1°C), correct the value according to the equation below.

$S_{20} = St + 0.007 (t-20)$

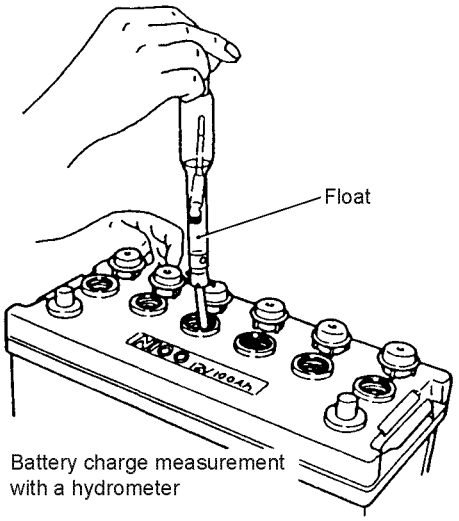
- S_{20}: Converted specific gravity at 68°F (20°C)
- St: Specific gravity at measurement
- t: Electrolyte temperature at measurement (°C)

	To convert	Into	Multiply by
Temperature	°C	°F	°C = 5/9 (°F = 32)

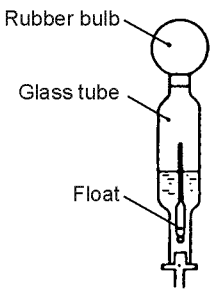
Specific gravity and remaining battery charge

Specific gravity 68°F (20°C)	Discharged quantity of electricity (%)	Remaining charge (%)
1.260	0	100
1.210	25	75
1.160	50	50
1.110	75	25
1.060	100	0

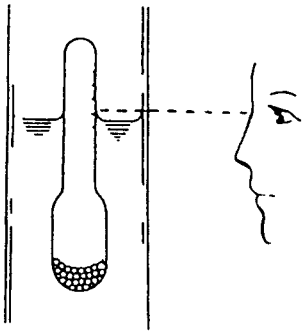
(3) Terminals
Clean if corroded or soiled.
(4) Mounting bracket
Repair or replace it if corroded. Retighten if loosened.
(5) Battery appearance
Replace the battery if cracked or deformed.
Clean with fresh water if contaminated.



Battery charge measurement with a hydrometer



Hydrometer structure


How to read hydrometer

4-3-10 Adjusting Operation

Perform adjusting operation as follows after the maintenance job:

(1) Supply the fuel oil, lubricating oil and cooling water.

Note :
Check the levels of the lubricating oil and cooling water again after test running (for about 5 minutes) and add as required.

(2) Start the engine, and carry out idling at a low revolution (700 to 900 RPM) for a few minutes.

(3) Run in the engine for about five minutes at the rated revolution (no-load). Check any water, fuel or oil leak and existence of abnormal vibration or noise. Also check the oil pressure, cooling water temperature and exhaust gas color.

(4) Adjust the no-load minimum and maximum revolutions according to the specifications.

(5) Perform loaded operation as required.

4-3-11 Long Storage

Observe the following instructions when the engine is to be stored for a long period without operation:

(1) Always drain cooling water in a cold season or before a long storage. (This is unnecessary when antifreeze is used.)

Notice :
Negligence of water draining will cause the cooling water remaining inside the engine to be frozen and expanded to damage the engine parts.

Water draining procedure

[1] Remove the radiator cap.
[2] Loosen the water draining cock under the radiator to drain water from the inside.
[3] Loosen the drain cock on the side surface of the cylinder to drain water from the inside.
[4] After draining water, tighten the radiator cap and drain plug and cocks.

(2) Remove the mud, dust and oil deposit and clean the outside.

(3) Perform the nearest periodic inspection before the storage.

(4) Drain or fill the fuel oil fully to prevent condensation in the fuel tank.

(5) Disconnect the battery cable from the battery negative (–) terminal.

(6) Cover the silencer, air cleaner and electric parts with PVC cover to prevent water and dust from depositing or entrance.

(7) Select a well-ventilated location without moisture and dust for storage.

(8) Perform recharging once a month during storage to compensate for self-discharge.

4-3-12 Periodic Maintenance Schedule

The engine periodic inspection timing is hard to determine as it varies with the application, load status, qualities of the fuel and lubricating oils used and handling status. General rules are described here.

○ : Inspection ◇ : Parts replacement

Classification	Item	Daily	Maintenance period				
			Every 50 hours	Every 250 hours	Every 500 hours	Every 1000 hours	Every 2000 hours
Fuel oil system	Fuel tank level check and fuel supply	○					
	Fuel tank draining		○				
	Water separator draining (Option)		○ Every 100 hours				
	Water separator cleaning (Option)				○		
	Fuel filter element replacement				◇		
Lube oil system	Lube oil level check	○					
	Lube oil replacement		◇ 1st time	◇ 2nd time and there after			
	Lube oil filter replacement						
Cooling water system	Cooling water level check and replenish	○					
	Radiator fin cleaning			○			
	Cooling fan V-belt tension check	○					
	Cooling water replacement					◇	
	Cooling water path flushing and maintenance					○ within one years	
Fuel oil, lube oil and cooling water leakage check		○					
Rubber hose	Fuel pipe and cooling water pipe inspection and maintenance						○
Air intake system	Air cleaner cleaning and element replacement			○	◇		
	Turbocharger blower cleaning					○	
Electrical system	Warning lamp & instruments function check	○					
	Battery electrolyte level check and battery recharging	○					
Cylinder head	Intake/exhaust valve head clearance adjustment					○	
Fuel injection pump and valve	Fuel injection valve pressure inspection					○	
	Fuel injection timing inspection						○

4-4 Engine Body

4-4-1 Introduction

Make preparation as follows before starting engine inspection and service :

(1) Fix the engine on a horizontal base.

⚠ CAUTION

Be sure to fix the engine securely to prevent injury or damage to parts due to falling during the work.

(2) Remove the cooling water hose, fuel oil pipe, wire harness, control wires etc. connecting the driven machine and engine, and drain cooling water, lubricating oil and fuel.

(3) Clean soil, oil, dust, etc. from the engine by washing with solvent, air, steam, etc. Carefully operate so as not to let any foreign matter enter the engine.

⚠ CAUTION

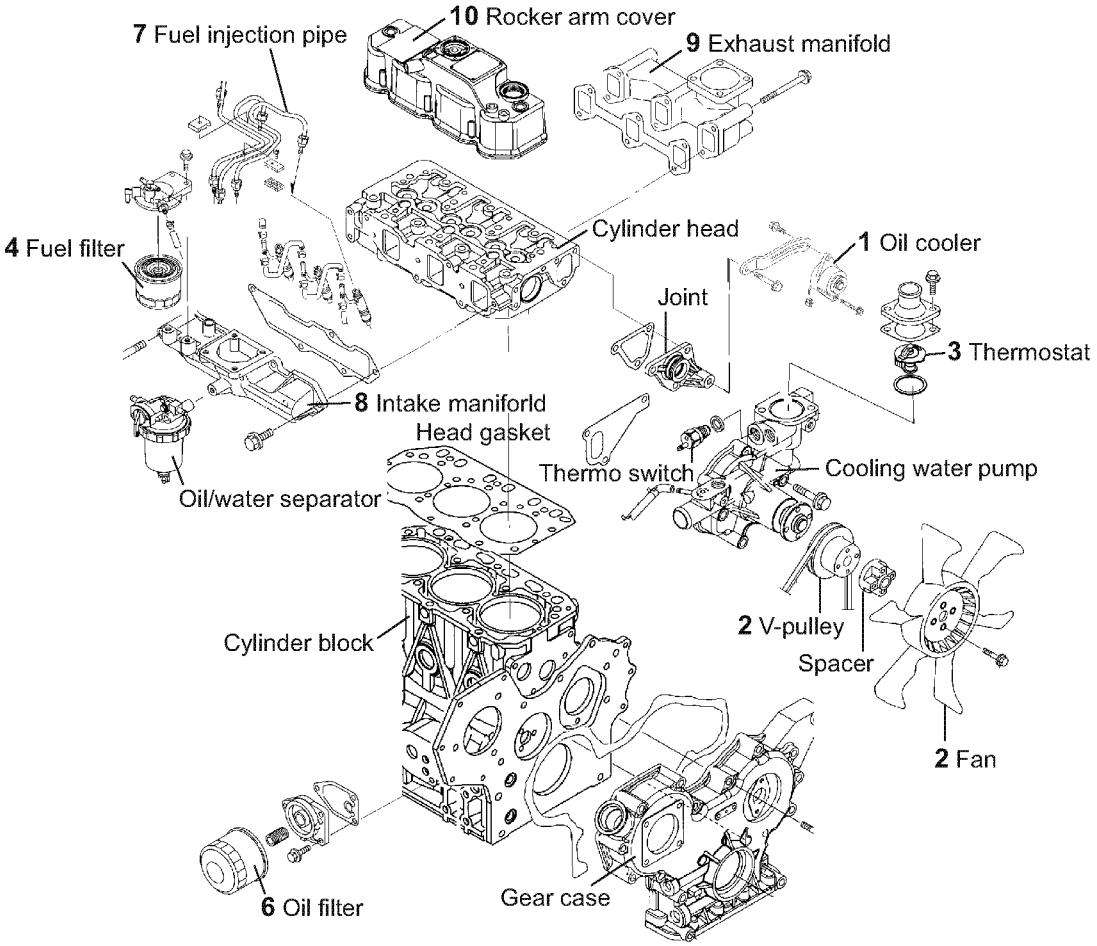
Always wear glasses or other protectors when using compressed air or steam to prevent any foreign matter from getting in the eyes.

Notice :

- *Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit shall be replaced.*
- *Any part predicted to dissatisfy the standard or limit before the next service as estimated from the state of use should be replaced even when the measured value then satisfies the standard or limit.*

4-4-2 Cylinder Head

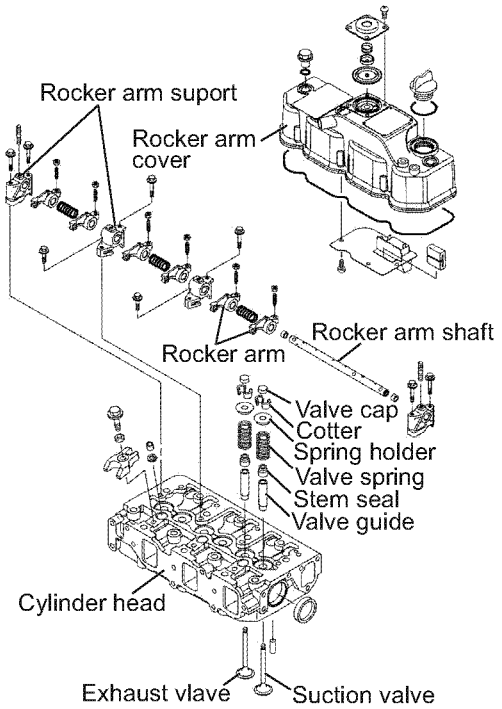
1) Components



2) Disassembly Procedure :

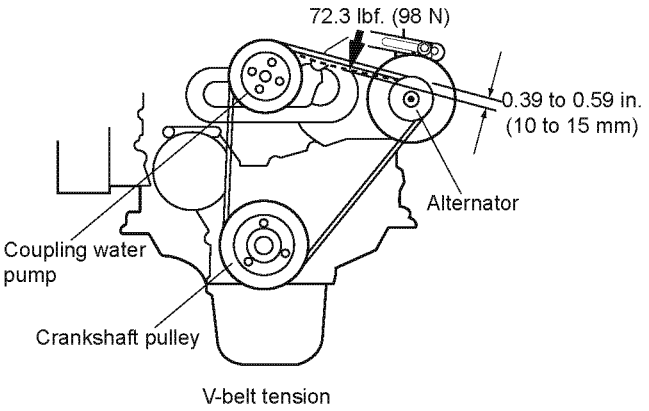
Disassemble in the order of the numbers shown in the illustration.

1 Remove the alternator ass'y. ***(Point 1)***
2 Remove the fan, pulley and V belt.
3 Remove the thermostat case. ***(Point 2)***
4 Remove the fuel filter and fuel oil piping. ***(Point 3)***
5 Remove the oil level gage ass'y.
6 Remove the oil filter. ***(Point 4)***
7 Remove the fuel injection pipes. ***(Point 5)***
8 Remove the intake manifold ass'y.
9 Remove the exhaust manifold ass'y.
10 Remove the rocker arm cover ass'y. ***(Point 6)***
11 Remove the rocker shaft ass'y, push rods and valve caps. ***(Point 7)***
12 Remove the cylinder head ass'y and head gasket. ***(Point 8)***
13 Remove the fuel injection valves and fuel return pipe. ***(Point 9)***
14 Remove the intake/exhaust valves, stem seals and valve springs. ***(Point 10)***
15 Remove the rocker arms from the rocker shaft.



3) Reassembly Procedure :

Reverse order of the disassembly procedure.



V-belt tension

4) Servicing Points

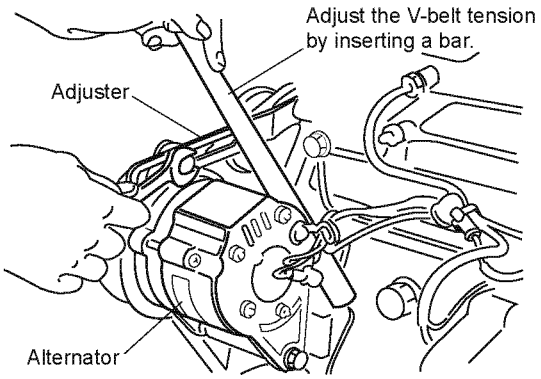
Point 1

Disassemble :

- Loosen the mounting bolt while supporting the alternator.

⚠ CAUTION

Do not tilt the alternator toward the cylinder block in a haste since it may damage the alternator or pinch a finger.



Tension adjustment

Reassemble :

- The belt deflection shall be 0.39 to 0.59 in. (10 to 15 mm) (0.28 to 0.35 in. (7 to 9 mm)) for a new belt).

Reassemble :

- Replace the belt with a new one if cracked, worn or damaged.
- Carefully prevent the belt from being smeared with oil or grease.

Point 2

Reassemble :

- Check the thermostat function.

Point 3

Reassemble :

- Replace the fuel filter element with a new one.

Disassemble :

- Cover the fuel pipe opening with tape to prevent intrusion of foreign matters.

Point 4

Reassemble :

- Replace the oil filter with a new one.
- After fully tightening the filter manually, retighten it with a filter wrench by 3/4 turn.

Point 5

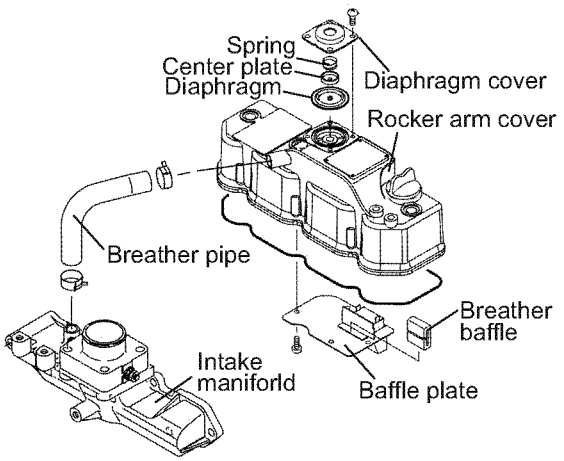
Disassemble :

- Cover the fuel injection pipe and pump inlets and outlets with tape or the like to prevent intrusion of foreign matters.

Point 6

Breather system (A redactor to intake air system of blowby gas)

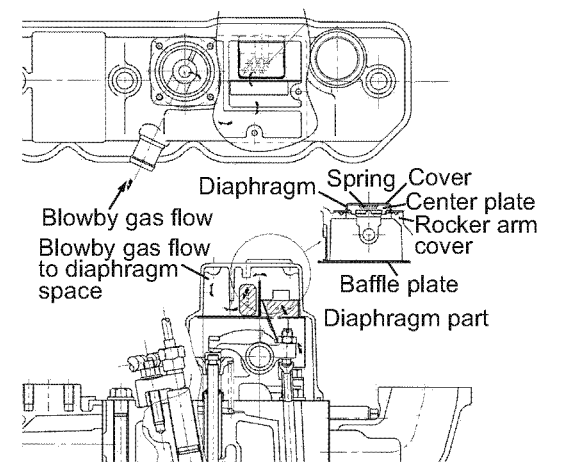
Emitting blowby gas is harmful to natural environment. Therefore blowby gas redactor is adopted to the engine. Some of the combustion gas passes through the clearance between the cylinder and the piston, piston ring, and flows to the crankcase. This is said as blowby gas. While it passes into the cylinder head and the rocker arm cover, the blowby gas mixes with splash oil, and becomes oil mist-blowby gas mixes with splash oil, and becomes oil mist-blowby gas it passing through the baffle plate inside a rocker arm cover. And it passes through a diaphragm assy, and a intake manifold, and is reduced in the combustion chamber. Pressure inside a crankcase is controlled by the function of the diaphragm assy, and suitable amount of blowby gas is reduced in intake air system.



Breather system componert

Disassemble :

- When a rocker arm cover is taken off, check whether oil or the like enter the diaphragm space from a small hole on the side of a diaphragm cover or not without disassembling the diaphragm.



Blowby gas flow

Notice :

- *When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles occur. When the internal pressure of the crankcase decreases too much due to the damage of a spring, much blowby gas containing oil is reduced in intake air system, and it may cause the combustion defect by the early dirt of the intake valve or the urgent rotation of the engine by the oil burning.*
  When pressure progresses in the crank case too much due to the wrong operation of the diaphragm and so on, it is considered that oil leakage from the joint of a oil pan, a oil seal and so on will occur. When a diaphragm is damaged, blowby is discharged from the breathing hole on the side of diaphragm cover, and not reduced in the intake manifold. Therefore, be careful of the diaphragm trouble.
- *At lubricating oil replacement or lube oil supply*
  The amount of lubricating oil isn't to be beyond the standard upper limit (in the engine horizontally, the upper limit mark of the dip stick). Since the blowby gas redactor is adopted, be careful that the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur, when the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine.

Reassemble :

- Replace the diaphragm with new one, when it is damaged.

Point 7

Disassemble :

- Keep the removed push rods by attaching tags showing corresponding cylinder Nos.

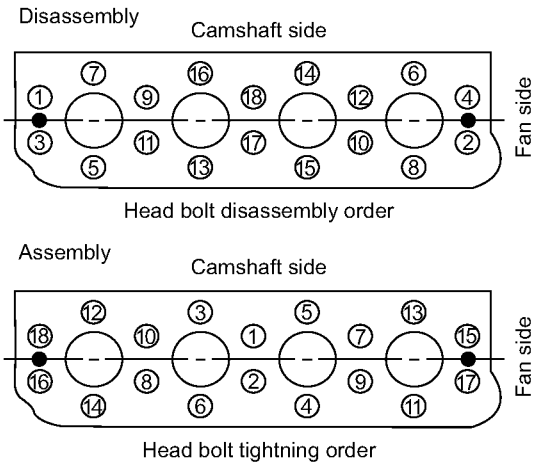
Reassemble :

- Always apply oil to the contact portions of the push rods and valve clearance adjusting screws.

Point 8

Disassemble :

- Loosen the cylinder head bolts in two steps in the illustrated order.
- Place the cylinder head ass'y on a paper board to prevent the combustion face from any damage.



Reassemble :

- Remove the head gasket with a new one.
- Uniformly install the head bolts manually after applying oil on the threaded and seat portions.
- They shall be tightened in two steps in the reverse of the order for disassembly.
  First step : T = 31.0 to 34.0 ft•lbf. (41.1 to 46.9 N•m)
  Second step : T = 63.0 to 67.0 ft•lbf. (85.3 to 91.1 N•m)

Point 9

Disassemble :

- Carefully remove the fuel injection valve so as not to leave the tip end protector from being left inside the cylinder.

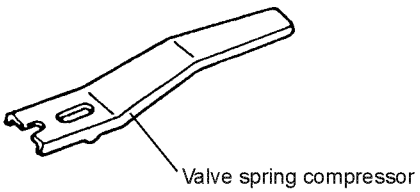
Reassemble :

- Replace the fuel injection valve protector with a new one.

Point 10

Disassemble :

- When removing each intake/exhaust valve from the cylinder head, use a valve spring compressor and compress the valve spring and remove the valve cotter.
- Keep each removed intake/exhaust valve after attaching a tag showing the corresponding cylinder No.



- If cotter burr is seen at the shaft of each intake/exhaust valve stem, remove it with an oilstone and extract the valve from the cylinder head.

Reassemble :

- Replace the stem seal with a new one when an intake/exhaust valve is disassembled.
- Carefully install each valve after oil application so as not to damage the stem seal.
- Different stem seals are provided for the intake and exhaust valves. Do not confuse them since those for exhaust valves are marked with yellow paint.
- After assembling the intake/exhaust valve, stem seal, valve spring, seat, and cotter, tap the head of the valve stem lightly for settling.
- Do not forget to install the valve cap.

5) Parts Inspection and Measurement

(1) Cylinder head

Clean the cylinder head, mainly the combustion surface, valve seats and intake/exhaust ports, remove carbon deposit and bonding agent, and check the surface state.

[1] Appearance check

Check mainly discoloration and crack.

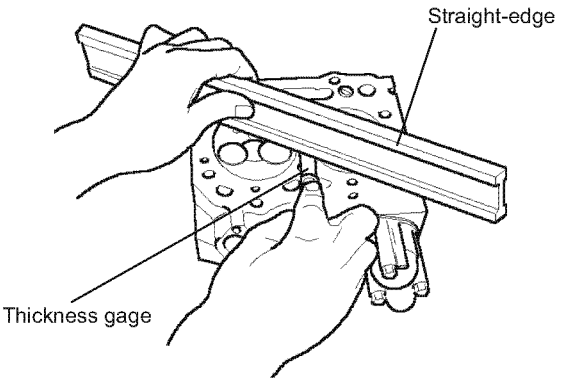
If crack is suspected, perform color check.

[2] Combustion surface distortion

Apply a strait-edge in two diagonal directions and on four sides of the cylinder head, and measure distortion with a thickness gage.

in. (mm)

	Standard	Limit
Distortion	0.002 (0.05) or less	0.006 (0.15)



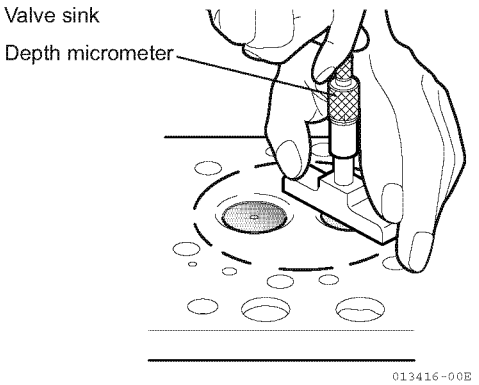
Distortion at combustion surface

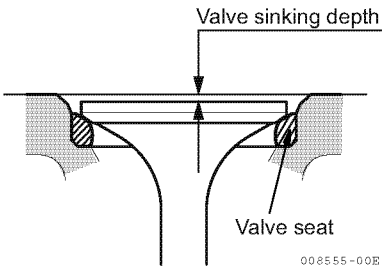
[3] Valve sink

Measure with the valve inserted to the cylinder head.

in. (mm)

		Standard	Limit
Valve sink	Intake	0.012 to 0.020 (0.30 to 0.50)	0.031 (0.8)
	Exhaust	0.012 to 0.020 (0.30 to 0.50)	0.031 (0.8)

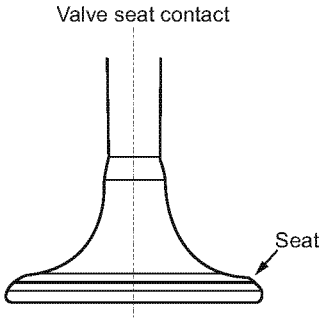




[4] Seat contact

Apply a thin coat of minium on the valve seat. Insert the valve in the cylinder and push it against the seat to check seat contact.

Standard : Continuous contact all around



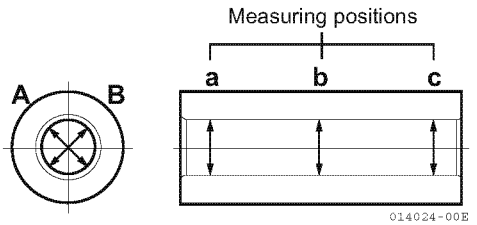
(2) Valve guide

Mainly check damage and wear on the inside wall. Apply supply part code 129907-11810 when replacing the part.

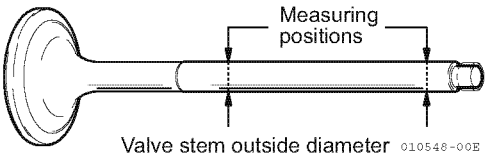
[1] Inside diameter

in. (mm)

		Standard	Limit
Intake valve	Guide I.D.	0.315 to 0.316 (8.010 to 8.025)	0.319 (8.10)
	Stem O.D.	0.313 to 0.314 (7.955 to 7.975)	0.311 (7.90)
	Clearance	0.0014 to 0.0028 (0.035 to 0.070)	0.071 (0.18)
Exhaust valve	Guide I.D.	0.316 to 0.317 (8.015 to 8.030)	0.319 (8.10)
	Stem O.D.	0.313 to 0.314 (7.955 to 7.970)	0.311 (7.90)
	Clearance	0.0018 to 0.0030 (0.045 to 0.075)	0.0071 (0.18)



Valve guide inside diameter



Valve stem outside diameter 010548-00E

(3) Intake/exhaust valve

Mainly clean and check damage and wear at the valve stem and seat.

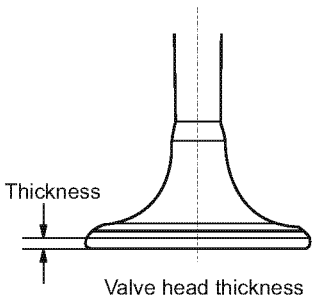
[1] Seat contact : See (1) [5] above.

[2] Stem outside diameter : See (2) [1] above.

[3] Valve head thickness

in. (mm)

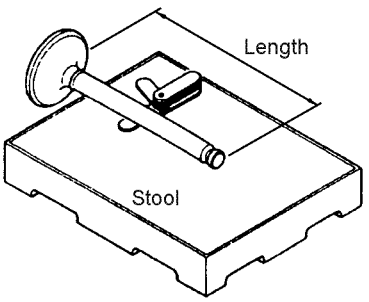
	Standard	Limit
Intake	0.049 to 0.057 (1.24 to 1.44)	0.031 (0.8)
Exhaust	0.053 to 0.061 (1.35 to 1.55)	0.031 (0.8)



Valve head thickness

[4] Valve stem bend

Limit	0.00039 in. (0.01 mm)



Valve bend and length

[5] Overall length

in. (mm)

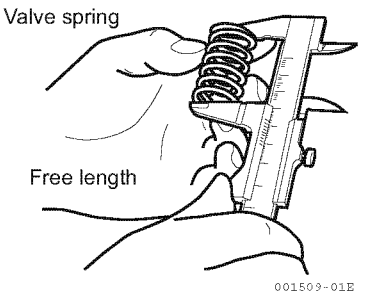
	Standard	Limit
Intake	4.280 to 4.303 (108.7 to 109.3)	4.272 (108.5)
Exhaust		

(4) Valve spring

Mainly inspect damage and corrosion.

in. (mm)

	Standard	Limit
Free length	1.654 (42.0)	1.634 (41.5)
Inclination	–	0.055 (1.4)



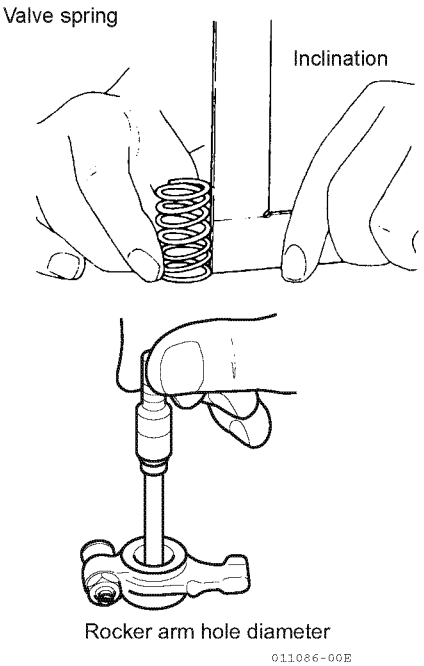
(5) Valve rocker arm

Mainly inspect valve head cap contact surface, inside surface defects and wear.

Slight surface defects shall be corrected with an oilstone.

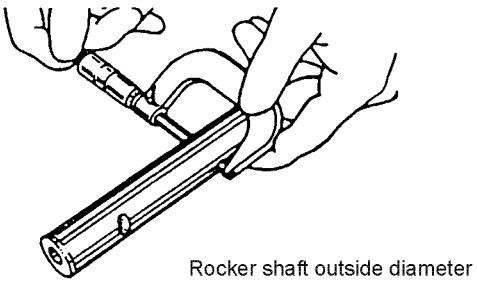
in. (mm)

	Standard	Limit
Arm hole diameter	0.6299 to 0.6307 (16.00 to 16.02)	0.6327 (16.07)
Shaft O.D.	0.6287 to 0.6291 (15.97 to 15.98)	0.6276 (15.94)
Clearance	0.0006 to 0.0021 (0.016 to 0.054)	0.051 (0.13)



(6) Valve rocker arm shaft

Mainly inspect seizure and wear at the surface in sliding contact with the arm. The rocker shaft diameter shall be as specified in (5) above.



(7) Push rod

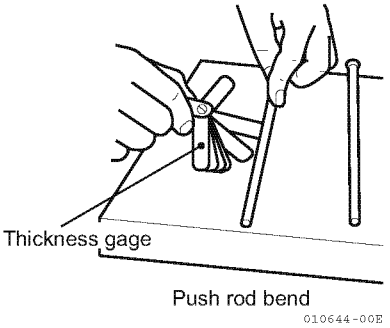
Mainly inspect the surface in contact with the tappet and adjusting screw. Slight defects shall be corrected with an oilstone.

Bend limit	0.0012 in. (0.03 mm) or less

(8) Valve clearance adjusting screw

Mainly inspect the surface in contact with the push rod.

Slight defects shall be corrected with an oilstone.



(9) Rocker arm spring

Mainly inspect surface defects and corrosion.

6) Valve Seat Correction

Notice :

Always check the oil clearance between the valve and valve guide before correcting the valve seat. If it exceeds the limit, replace the valve or valve guide first to make the clearance satisfy the standard. After correction, wash the valve and the cylinder head sufficiently with diesel oil to remove all grinding power or compound.

[1] If the seat surface is slightly roughened : perform **[A]** and **[B]** below.

[2] If the seat is heavily roughened but the width is almost normal, correct with a seat grinder or seat cutter first. Then perform lapping **[A]** and **[B]** below.

degrees

Seat cutter angle	Intake	Exhaust
	120	90

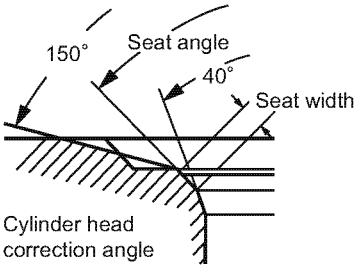
[3] If the seat is heavily roughened and the width is much enlarged, grind the seat inner surface with a seat grinder whose center angle is 40 degrees, then grind the seat outer surface with a grinder whose center angle is 150 degrees to make the seat width match the standard. Then perform seat correction as described in [2], and then carry out lapping **[A]** and **[B]** below.

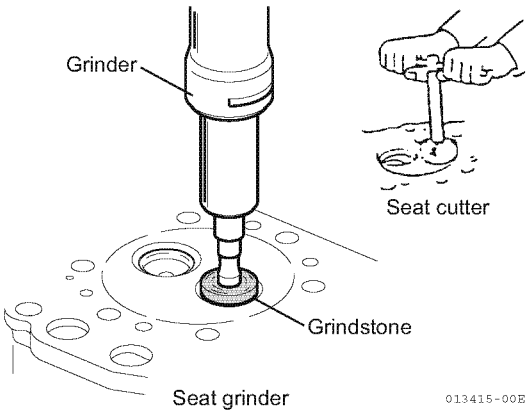
degrees

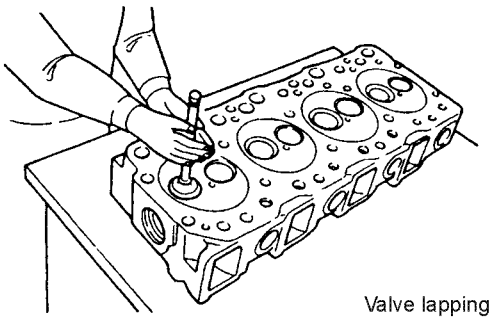
Grinding wheel angle	θ_1	θ_2
	40	150

[A] : Lap the valve and seat with a mixture of valve compound and engine oil.

[B] : Lap with engine oil only.

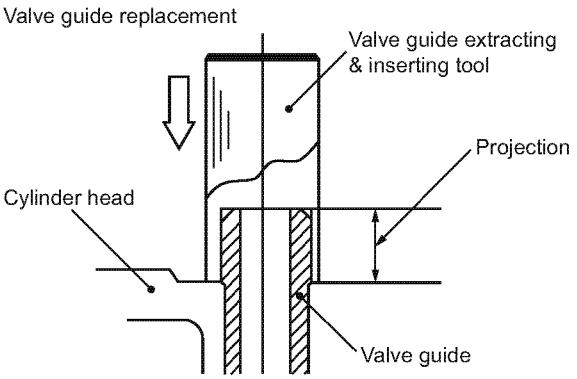






7) Valve Guide Replacement

[1] Use a valve guide extraction tool and extract the valve guide from the cylinder head.
[2] Put liquid nitrogen or ether (or alcohol) with dry ice added in a container and put the valve guide for replacement in it for cooling. Then insert it in with a valve guide inserting tool.
[3] Check the inside diameter and finish to the standard inside diameter as required with a reamer.
[4] Check the projection from the cylinder head.
Projection : 0.579 to 0.591 in. (14.7 to 15.0 mm)



⚠ CAUTION

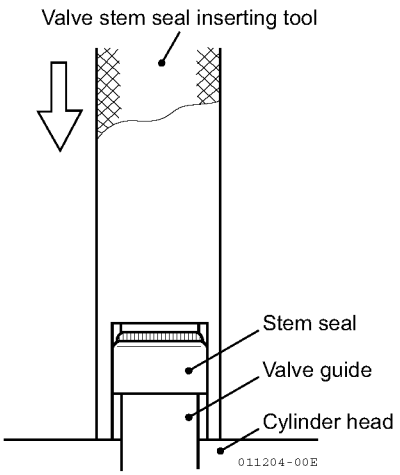
Do not touch the cooled valve guide with bare hands to avoid skin damage.

8) Valve Stem Seal Replacement

Always use a new seal after the intake/exhaust valve is disassembled. Since the one for the exhaust valve is marked with yellow paint, do not confuse the intake and exhaust valves.

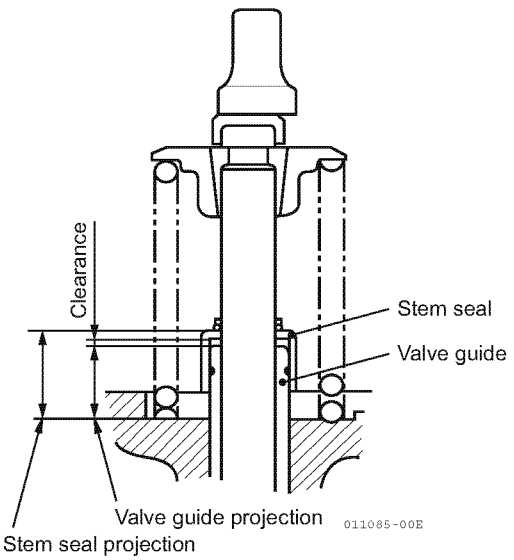
[1] Apply engine oil to the lip.

[2] Push with the inserting tool for installation.



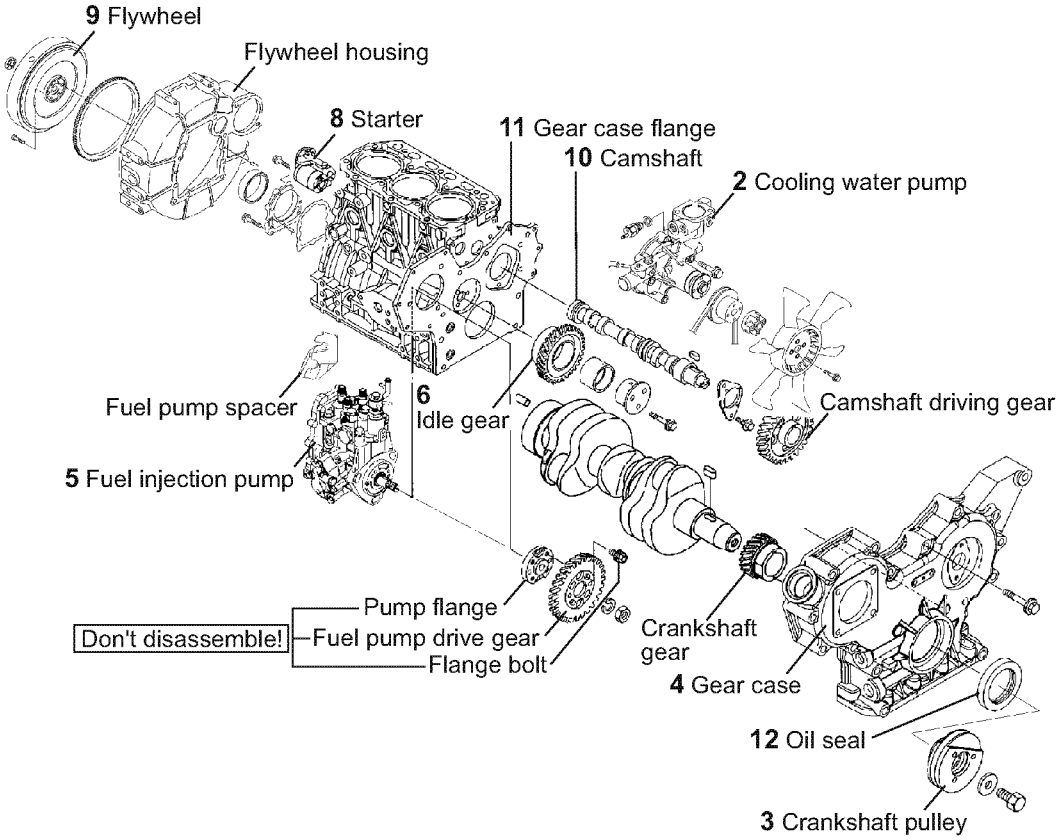
[3] Measure and check the projection of valve stem seal to keep proper clearance between valve guide and stem seal.

Stem seal projection : 0.736 to 0.748 in. (18.7 to 19.0 mm)



4-4-3 Gear Train and Camshaft

1) Components



2) Disassembly Procedure :

Disassemble in the order of the numbers in the illustration.

1 Perform steps 1 to 12 of the cylinder head disassembly procedure.
2 Remove the cooling water pump.
3 Remove the crankshaft pulley. ***(See Point 1)***
4 Remove the gear case cover. ***(See Point 2)***
5 Remove the fuel injection pump. ***(See Point 3)***
6 Remove the idle gear assy. ***(See Point 4)***
7 Remove the P.T.O. drive gear. ***(See Point 5)***
8 Remove the starting motor.
9 Remove the flywheel. ***(See Point 6)***
10 Remove the camshaft assy. ***(See Point 7)***
11 Remove the gear case. ***(See Point 8)***
12 Remove the oil seal from the gear case cover.

3) Reassembly Procedure :

Reverse of the disassembly procedure.

4) Servicing Points

Point 1

Disassemble :

- Remove the crankshaft pulley using a gear puller after removing the mounting bolt. When removing the pulley with the gear puller, use a pad and carefully operate so as not to damage the thread. Set the gear puller securely to prevent the pulley from being damaged.

Reassemble :

- When installing the crankshaft pulley, apply lube oil to the bolt and carefully assemble so as not to damage the oil seal.
  T = 83.2 to 90.4 ft•lbf. (113 to 123 N•m)

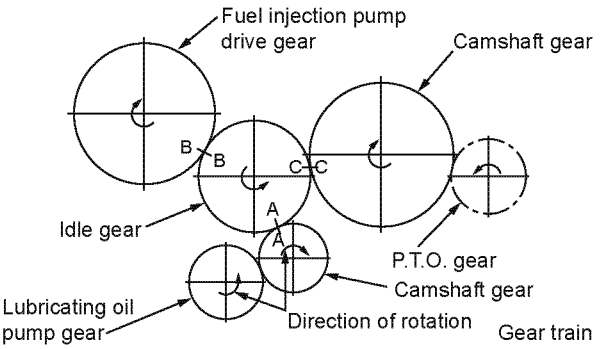
Point 2

Reassemble :

- When installing the gear case cover, do not forget to install the two reinforcing bolts at the center.
- Measure the backlash of each gear.

in. (mm)

	Standard	Limit
Crankshaft gear, Camshaft gear, Fuel injection pump gear, Idle gear, P.T.O. gear	0.0028 to 0.0059 (0.07 to 0.15)	0.0067 (0.17)
Lubricating oil pump gear	0.0043 to 0.0075 (0.11 to 0.19)	0.0083 (0.21)



- Apply sealant and install the gear case cover by correctly positioning the two dowel pins.

Point 3

Disassemble :

- Remove the fuel injection pump drive gear mounting nut, remove the gear using the gear puller, and remove the fuel injection pump. Do not forget to remove the stay on the rear side. When extracting the gear using the gear puller, use a pad at the shaft and carefully operate so as not to damage the thread.

Reassemble : • Drive gear nut T = 57.9 to 65.1 ft•lbf. (78 to 88 N•m)

Point 4

Reassemble :

- Assemble crankshaft gear A, fuel injection pump drive gear B and camshaft gear C at the same time by aligning with idle gear A, B and C marks.
- Install the idle gear shaft with the oil hole facing upward.

Point 5

Reassemble :

- Install the P.T.O. drive gear with its inner spline side facing the flywheel.

Point 6

Disassemble :

- Install a bolt as a handle in the hole at the end face of the flywheel and remove carefully so as not to damage the ring gear.

  Reassemble : Flywheel mounting bolt T = 61.5 to 65.1 ft•lbf. (83.3 to 88.2 N•m), apply lube oil

Point 7

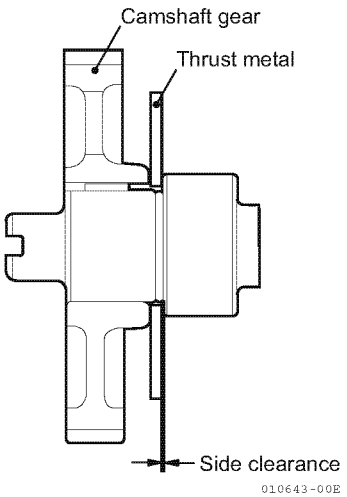
Disassemble :

- Measure the camshaft side gap.

in. (mm)

	Standard	Limit
Side gap	0.002 to 0.0079 (0.05 to 0.20)	0.0118 (0.30)

- If the measured side gap exceeds the limit, replace the thrust metal.



Disassemble :

- Since the camshaft gear is shrink-fit, heat it to 356 to 392°F (180 to 200°C) for extraction.
- For camshaft removal, raise the engine with its mounting flange at the bottom. After removing the thrust metal mounting bolt from the camshaft gear hole, extract the camshaft carefully so as not to damage the bearing bushing.
- Rotate the camshaft a few turns before extracting it to prevent the tappet from being caught by the cam.
- After removing the camshaft, set the engine horizontal and fix it on the base.

⚠ CAUTION

Unforeseen injury may arise due to falling of slipping when raising the engine vertically or returning it to the horizontal position. Proceed carefully so as not to lose balance.

Point 8

Reassemble :

- Do not forget to install the oil pan mounting bolts on the bottom side when installing the gear case.
- Apply sealant (code No.977770-01212) and install the gear case by matching the two dowel pins.

Point 9

Reassemble :

- Replace the oil seal whenever disassembled.
- Apply lithium grease at the time of assembly.

5) Parts Inspection and Measurement

(1) Camshaft

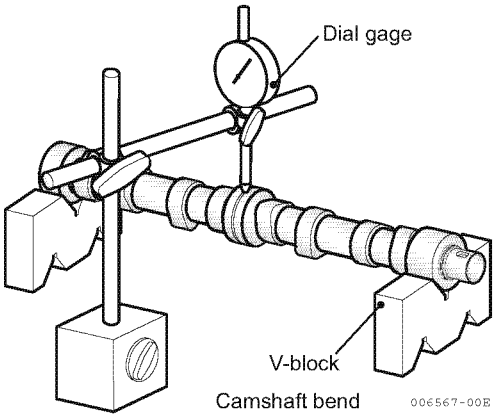
Mainly check the contact between the tappet and cam contact surface, bearing seizure and wear, and gear damage.

[1] Shaft bend measurement

Support the camshaft with V blocks. Rotate the camshaft and measure the runout at the center of the camshaft and at each journal with a dial gage. Half of the runout is the bend.

in. (mm)

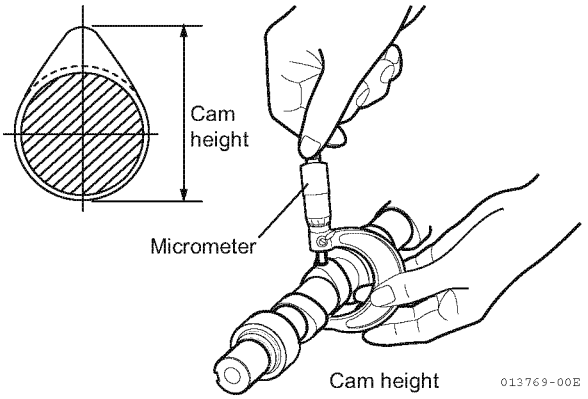
	Standard	Limit
Bend	0 to 0.0008 (0 to 0.02)	0.0020 (0.05)



[2] Intake/exhaust cam height measurement

in. (mm)

	Standard	Limit
Cam height	1.520 to 1.528 (38.600 to 38.800)	1.510 (38.350)

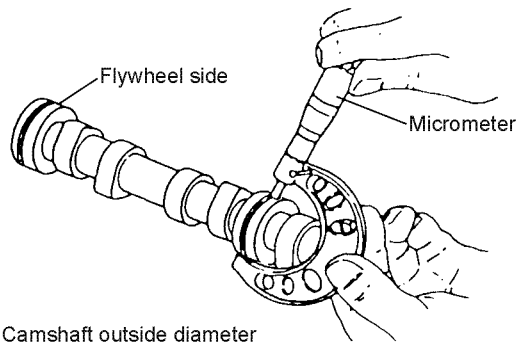


[3] Camshaft outside diameter and bearing hole diameter measurement

Measure the camshaft outside diameter with a micrometer. The oil clearance shall be calculated by subtracting the measured camshaft outside diameter from the camshaft bushing inside diameter after insertion to the cylinder measured with a cylinder gage.

in. (mm)

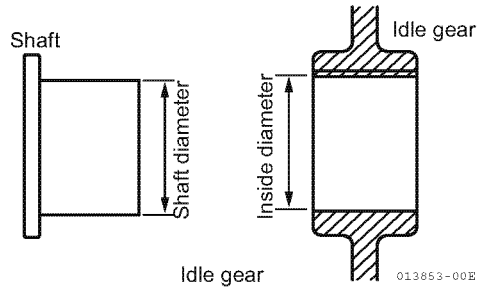
		Standard	Limit
Gear side	Camshaft O.D.	1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
	Bushing I.D.	1.7713 to 1.7738 (44.990 to 45.055)	1.7768 (45.130)
	Oil clearance	0.0016 to 0.0051 (0.040 to 0.130)	0.0094 (0.240)
Intermediate position	Camshaft O.D.	1.7681 to 1.7691 (44.910 to 44.935)	1.7667 (44.875)
	Bushing I.D.	1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
	Oil clearance	0.0026 to 0.0045 (0.065 to 0.115)	0.0089 (0.225)
Wheel side	Camshaft O.D.	1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
	Bushing I.D.	1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
	Oil clearance	0.0020 to 0.0039 (0.050 to 0.100)	0.0083 (0.210)



(2) Idle gear

Mainly check the bushing seizure and wear, and gear damage.

[1] Shaft outside diameter and bushing inside diameter measurement



in. (mm)

	Standard	Limit
Shaft outside diameter	1.8091 to 1.9675 (45.950 to 49.975)	1.8071 (45.009)
Bushing inside diameter	1.8110 to 1.8120 (46.000 to 46.025)	1.8140 (46.075)
Clearance	0.0010 to 0.0030 (0.025 to 0.075)	0.0069 (0.175)

(3) P.T.O. drive gear

Mainly check sticking of bearings on both sides, gear damage and looseness, and gear shaft damage and wear.

6) Oil Seal Replacement (Gear Case Side)

[1] Replace the oil seal with a new one when the gear case is disassembled.
Extract the used oil seal.

[2] Insert a new oil seal. Fit the position of the oil seal insertion to the end face of the gear case.
(Refer to the below figure.)

[3] Apply lithium grease to the oil seal tips. For the oil seal with double lips dust seal, further, lightly apply engine oil on the oil seal lip so as not to damage them, when installing the pulley.

Notice :

Pay attention not to drop any oil on the taper surface of the crankshaft. If dropped, clean by wiping off using detergent.

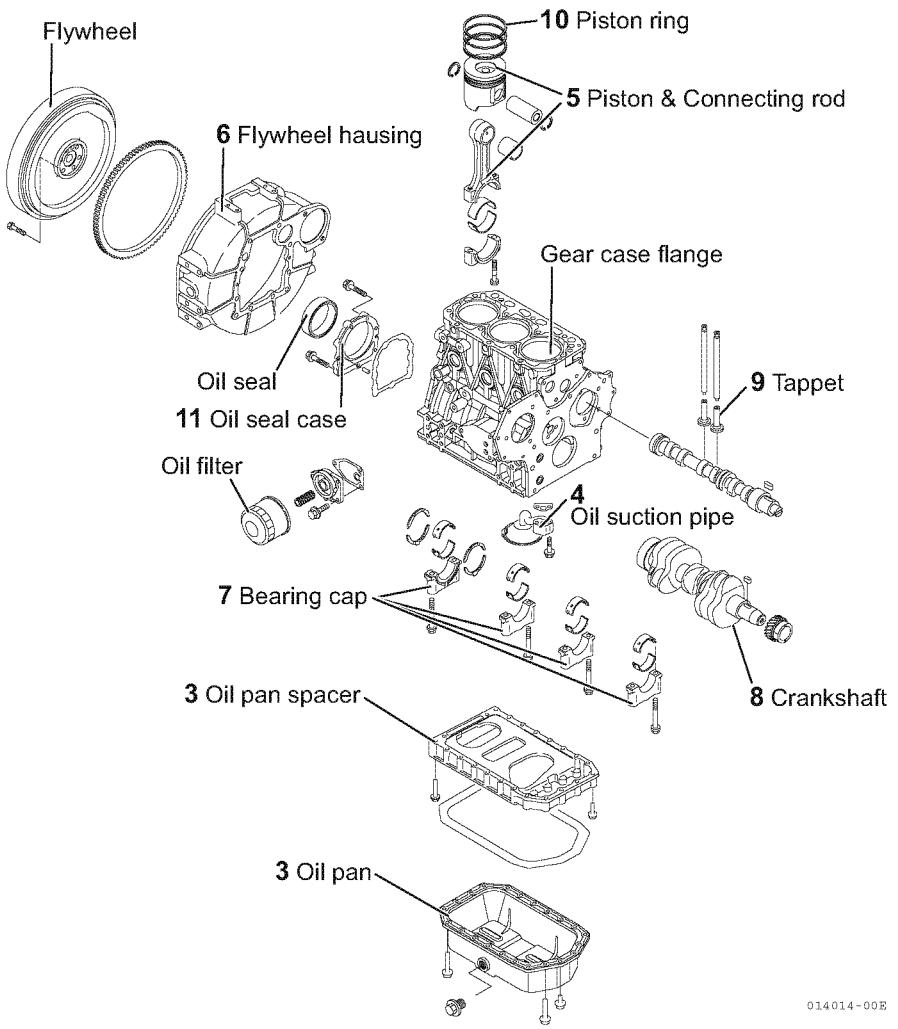
[4] Carefully install the crankshaft pulley so as not to damage the oil seal lips.

7) Camshaft Bushing Replacement

Replace the bushing using the special service tool.

4-4-4 Cylinder Block

1) Components



2) Disassembly Procedure :

Disassemble in the order of the numbers in the illustration.

1 Perform steps 1 to 12 in the cylinder head disassembly procedure.
2 Perform steps 1 to 12 in the gear train disassembly procedure.
3 Remove the oil pan. ***(See Point 1)***
4 Remove the lubricating oil suction pipe.
5 Remove the piston w/rod. ***(See Point 2)***
6 Remove the mounting flange. ***(See Point 3)***
7 Remove the bearing metal caps. ***(See Point 4)***
8 Remove the crankshaft. ***(See Point 5)***
9 Remove the tappets.
10 Remove the pistons and rings. ***(See Point 6)***
11 Remove the oil seal from the mounting flange.

3) Reassembly Procedure :

Reverse of the disassembly procedure.

4) Servicing Points

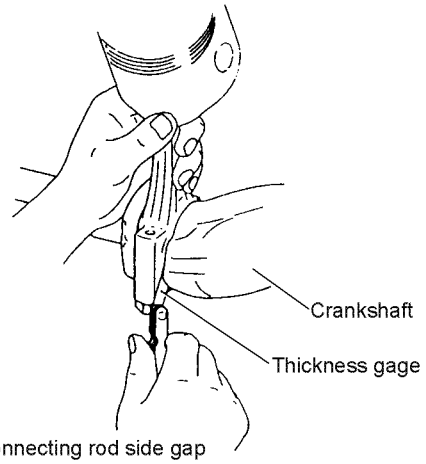
Point 1 Oil pan

Disassemble :

- Sealant is applied to the oil pan mounting surface on the block. Carefully operate so as not to damage or distort the bonding surface.

Reassemble :

- Apply sealant (code No.977770-01212) before reassembly.



Point 2 Piston w/rod

Disassemble :

- Measure the connecting rod side gap.
  Standard : 0.0079 to 0.0157 in. (0.20 to 0.40 mm)
- Carefully remove the carbon deposit on top of the cylinder so as not to damage the inner side of the cylinder.
- Set the piston at the BDC position and remove the connecting rod cap. Then set the piston at the TDC position, and push the connecting rod big end with the wooden shaft of a hammer. Proceed carefully so as not to cause the cylinder block catch the rod big end. Set the rod caps and crankpin metals in their correct combinations.

Reassemble :

- Apply oil especially carefully to the sliding contact surfaces of the pistons, rods and rings.
- Use the piston insertion tool to insert each piston w/rod in the cylinder block and install the bearing metal cap.
  Rod bolt tightening torque : T = 33.0 to 36.0 ft•lbf. (44.1 to 49.0 N•m), apply lube oil

Point 3 Mounting flange

Disassemble :

- Place the engine on a stable base with the cylinder block upper surface facing down, and remove the mounting flange carefully so as not to damage the combustion surface.

Reassemble :

- Apply sealant (code No.977770-01212) and install the mounting flange by matching the two dowel pins. After assembly, raise the engine with its mounting flange on the bottom side.

⚠ CAUTION

Unforeseen injury may arise due to falling of slipping when raising or reversing the engine. Carefully operate so as not to lose balance.

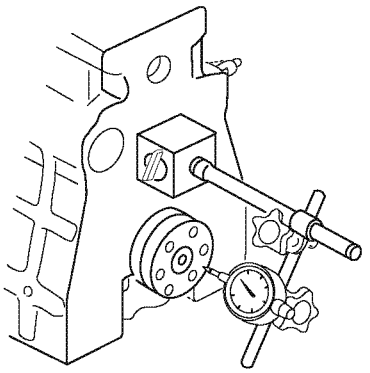
Point 4 Journal bearing cap

Disassemble :

- Before removing the journal bearing, measure the crankshaft side gap. Measure it in either method because there are the next two methods.

[1] Install a dial gage on the cylinder block, and move a crankshaft in front and back, and measure the side gap as shown in the right figure.

[2] Put a thickness gauge in the clearance between thrust metal and crankshaft directly, and measure it.

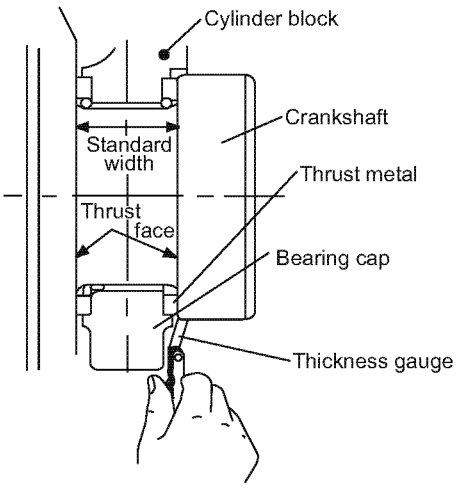


Side gap measurement 1

Side gap standard

in. (mm)

Model	Standard	Limit
All models	0.0051 to 0.0091 (0.13 to 0.23)	0.0110 (0.28)



Side gap measurement 2

Reassemble :

- If the side gap exceeds the standard, replace the thrust metal with an oversize one.
  Machine the standard width of the crankshaft thrust part into the dimension of the below table at the same time.
  Refer to a parts catalog when ordering the part.

  The surface finishing precision (refer to 4.4.5(2) in Chapter4): 1.6

0.0098 in. (0.25 mm) Oversized thrust metal (0.25 DS)

in. (mm)

Thrust metal assy code	Standard thickness
129150-02940	0.0809 to 0.0829 (2.055 to 2.105)

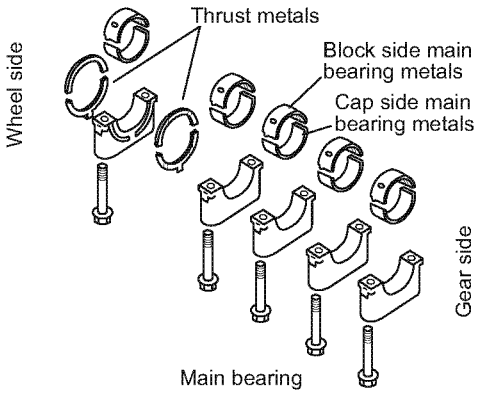
The standard width of the crankshaft thrust part

in. (mm)

Model	Standard thickness
3TNV88	1.1122 to 1.1130 (28.250 to 28.271)

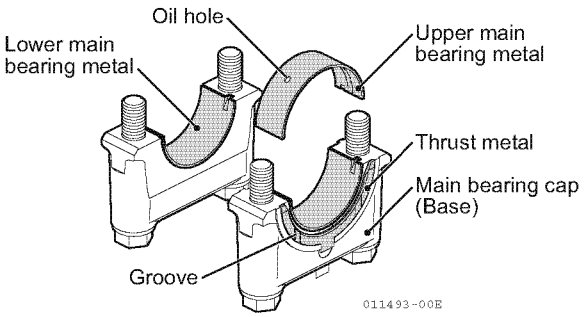
Disassemble :

- Remove the bearing caps, cap side bearings, and thrust metals. Place each thrust metal with identification of the position and direction.
  The position number of reassembling is punched on a metal cap (except for both ends) and a cylinder block.



Reassemble :

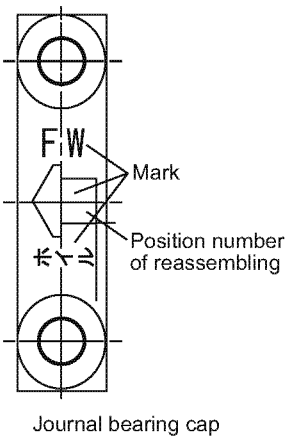
- Carefully install each thrust metal so that the grooved one is positioned away from the cap.
- Do not confuse the upper and lower main bearing metals. The upper main bearing metal (block side) has an oil hole, and the lower one does not. The “arrow” marks on the cap shall face the flywheel. Tighten main bearing cap bolts.



Main bearing cap bolt tightening torque
(apply lube oil)

ft•lbs (N•m)

Standard
69.0 to 76.0 (93.2 to 98.1)



Point 5 Crankshaft

Disassemble :

- Remove the crankshaft. Remove each main bearing metal upper (block side) and pair it with the metal cap side lower metal.

⚠ CAUTION

Carefully prevent damage to the bearing or finger injury when removing the crankshaft because it is heavy.

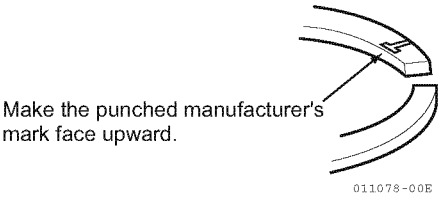
Point 6 Piston pin and rings

Disassemble :

- Use the piston ring replacer, remove the piston rings.
- Remove the circlip and remove the piston pin by pushing it out.

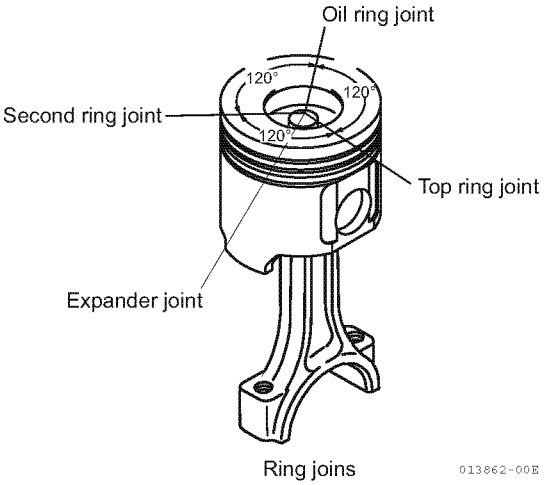
Reassemble :

- Install each piston ring on the piston, with the punched manufacturer's mark facing upward.



Reassemble :

- The piston ring joints shall be staggered at by 120 degrees intervals. Do not position the top ring joint vertical to the piston pin. The coil expander joint shall be opposite to the oil ring joint.

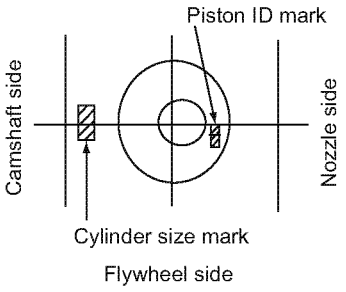


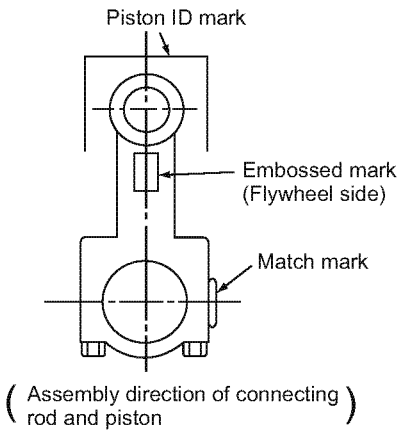
Reassemble :

- When installing the piston pin to the rod and piston, the punched match mark on the big end of the connecting rod shall be opposite to the size mark on the piston top.

Reassemble :

- Install the piston in the cylinder block with the punched mark on the big end of the rod on the nozzle side.(The embossed mark at the connecting rod I-beam section shall be on the flywheel side.)





Point 7 Oil seal

Reassemble :

• Replace the oil seal with a new one whenever disassembled. Apply lithium grease at the time of assembly.

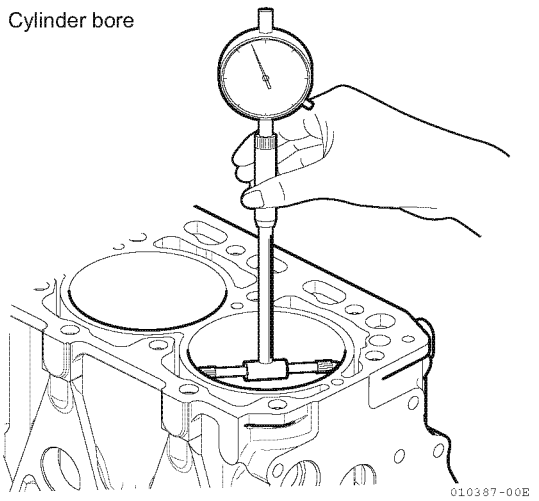
5) Parts Inspection and Measurement

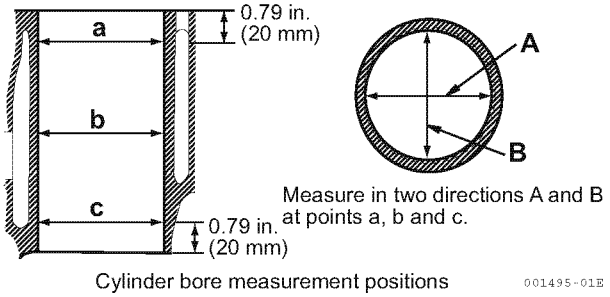
(1) Cylinder block

Especially clean head surface, cylinder bores and oil holes, and check after removing any carbon deposit and bonding agent.

[1] Appearance inspection
Check if there is any discoloration or crack. If crack is suspected, perform color check. Sufficiently clean the oil holes and check they are not clogged.

[2] Cylinder bore and distortion
Measure at 0.39 in.(10 mm) below the crest of the liner, at 0.79 in.(20 mm) from the bottom end and at the center.
Roundness : Maximum value of the difference between the measured values in the same cross section.
Cylindricity : Maximum value of the difference between the measured values in the same direction.





Cylinder bore measurement positions 001495-01E

in. (mm)

	Standard	Limit
Bore	3.4646 to 3.4657 (88.000 to 88.030)	3.4724 (88.200)
Roundness	0.0004 (0.01) or less	0.0012 (0.03)
Cylindricity	0.0004 (0.01) or less	0.0012 (0.03)

[3] If the limit is exceeded or any surface defect is found, repair by boring and honing. Use an oversized piston (and new piston rings) as required.

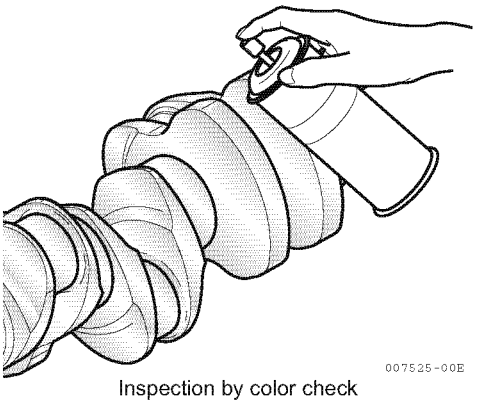
0.25 OS	Piston ass'y code (incl./Piston ring ass'y)	Piston ring ass'y code	Boring dimension in. (mm)
	129005-22900	129005-22950	Ø3.4744 to Ø3.4756 (Ø88.250 to Ø88.280)

(2) Crankshaft

Mainly check seizure and wear of the crankpins and journals. Since the crankshaft gear is shrink-fitted, heat to 356 to 392°F (180 to 200°C) when extraction is necessary.

[1] Shaft portion color check

After washing the crankshaft, inspect it by means of color check or a magnaflux inspector. Replace it if cracked or heavily damaged. Slight defects shall be corrected by grinding.

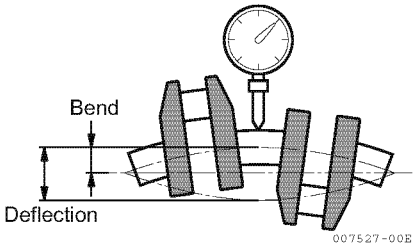


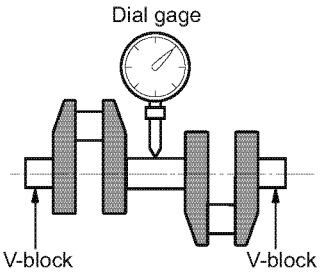
Inspection by color check

[2] Crankshaft bend

Support the crankshaft journals at both ends with V-blocks. Use a dial gage and measure the runout at the center journal while rotating the shaft to inspect the bend.

Limit	0.00079 in. (0.02 mm) or less



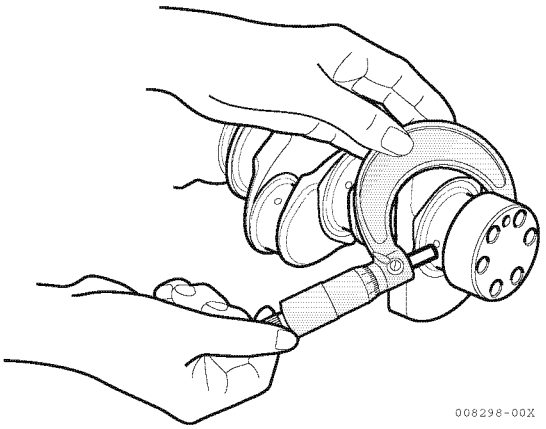


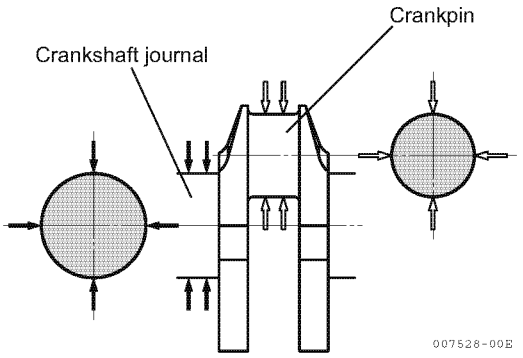
Crankshaft bend measurement
014025-00E

[3] Crankpin and journal measurement

Measure the outside diameter, roundness and taper at each crankpin and journal.

Correct by grinding if unevenly wear, roundness exceeding the limit or insufficient outside diameter is found. Replace if the defect is excessive.





Measuring position of the crankpin and crank journal

• Crankpin

in. (mm)

	Standard	Limit
Pin outside diameter	1.8879 to 1.8883 (47.952 to 47.962)	2.2796 (47.902)
Metal thickness	0.0587 to 0.0591 (1.492 to 1.500)	–
Oil clearance	0.0015 to 0.0029 (0.038 to 0.074)	0.0059 (0.150)

If the oil clearance exceeds the limit, use an undersized bearing.

0.25 US bearing

in. (mm)

Part code	129150-23610
Standard thickness	0.0637 to 0.0640 (1.617 to 1.625)
Pin machining dimension	Ø1.8780 to Ø1.8784 (Ø47.702 to Ø47.712)

• Crank journal

in. (mm)

	Standard	Limit
Journal O.D.	2.1241 to 2.1245 (53.952 to 53.962)	2.1221 (53.902)
Metal thickness	0.0786 to 0.0783 (1.995 to 1.990)	–
Oil clearance	0.0015 to 0.0027 (0.038 to 0.068)	0.0059 (0.150)

If the clearance limit is exceeded, use an undersized bearing.

• 0.25 US Crank journal bearing

in. (mm)

Part code	129150-02870
Standard thickness	0.0831 to 0.0837 (2.112 to 2.125)
Journal bearing machining dimension	Ø2.1142 to Ø2.1146 (Ø53.702 to Ø53.712)

Notice :

- *If the oil clearance is excessive though the thicknesses of the journal and crankpin metals are normal or if partial uneven wear is observed, re-grind the crankshaft and use an oversized metals.*
- *If rust or surface roughening exists on the rear side of the metals, coat it with blue or minimum. Then assemble the crankpin metal to the connecting rod, and tighten the rod bolt to the specified torque to check the metal for contact. If the contact surface occupies 75% or more, the metal is normal. If the contact surface is insufficient, the metal interference is insufficient. Replace the metal with a new one.*

(3) Thrust metal inspection

Inspect any damage or wear.

[1] Thickness

in. (mm)

	Standard	Limit
Thickness	0.0760 to 0.0780 (1.930 to 1.980)	0.0728 (1.850)

[2] Side gap

in. (mm)

	Standard	Limit
Side gap	0.0055 to 0.0087 (0.14 to 0.22)	0.0110 (0.28)

If the side gap is exceeded, use an oversized thrust metal.

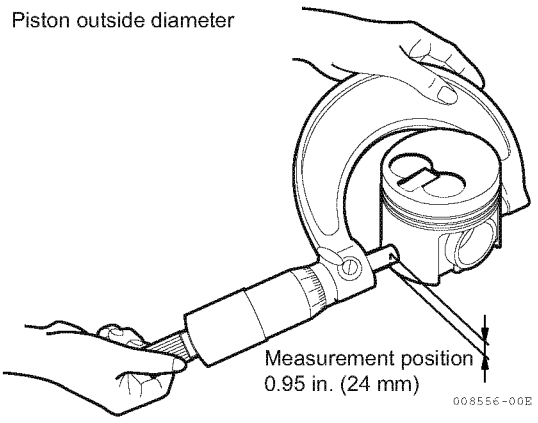
0.25 OS	129150-02940
Standard thickness	0.0809 to 0.0829 in. (2.055 to 2.105 mm)

(4) Piston

Especially clean the combustion surface, circumference, ring grooves and piston pin bosses, and check after removing any carbon deposit. Any burr at a ring groove or snap ring groove shall be removed. If crack is suspected, inspect by color check.

[1] Piston outside diameter measurement

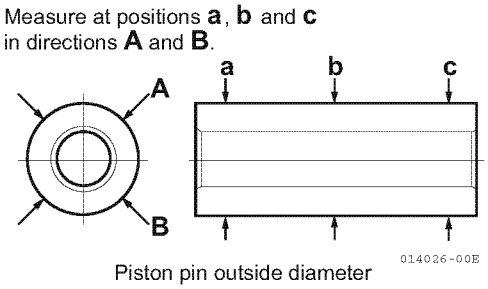
Measure the long diameter at 0.95 in. (24 mm) from the bottom end of the piston of the oval hole in the vertical direction to the piston pin hole.



in. (mm)

		Standard	Limit
Long diameter		3.4622 to 3.4634 (87.940 to 87.970)	3.4604 (87.895)
Clearance between piston and cylinder	Min.	0.0018 (0.045)	0.0016 (0.040)
	Max.	0.0030 (0.075)	0.0028 (0.070)

If the clearance between piston and cylinder exceeds the limit, use an oversized piston.



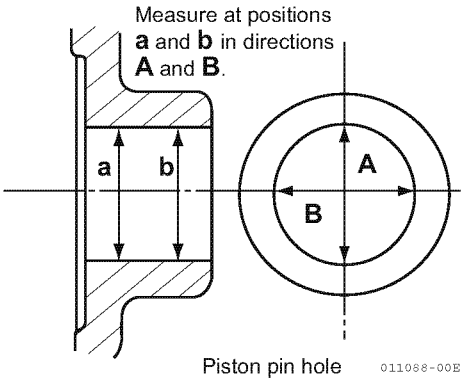
Piston pin outside diameter

0.25 OS	Piston ass'y code (incl./Piston ring ass'y)	Piston ring ass'y code	Boring dimension in. (mm)
	129005-22900	129005-22950	Ø3.4744 to Ø3.4756 (Ø88.250 to Ø88.280)

[2] Piston pin hole measurement

in. (mm)

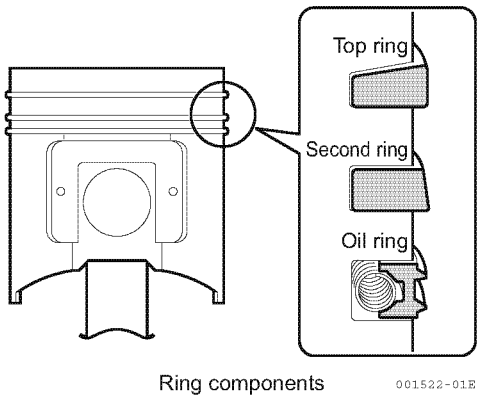
	Standard	Limit
Pin hole diameter	1.0236 to 1.0240 (26.000 to 26.009)	1.0252 (26.039)
Pin outside diameter	1.0234 to 1.0236 (25.995 to 26.000)	1.0222 (25.965)
Oil clearance	0.000 to 0.0006 (0.000 to 0.014)	0.0029 (0.074)



Piston pin hole 011088-00E

[3] Piston ring, ring groove and end clearance measurement

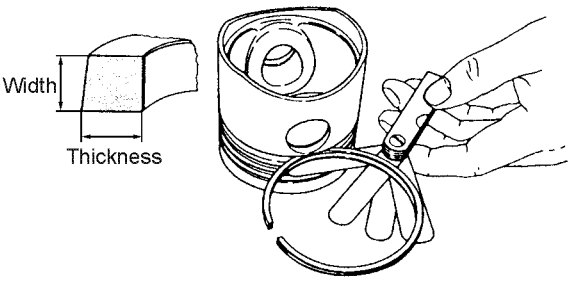
- Except for the top ring, to measure the piston ring groove width, first measure the width of the piston ring. Then insert the piston ring into the ring groove. Insert a thickness gage in between the piston ring and groove to measure the gap between them. Obtain the ring groove width by adding ring width to the measured side clearance.
- To measure the end clearance, push the piston ring into the sleeve using the piston head, insert a thickness gage in end clearance to measure. The ring shall be pushed in to approx.1.18 in. (30 mm) above the bottom end of the cylinder. For the top ring, measure only the piston ring joint end clearance in normal state.



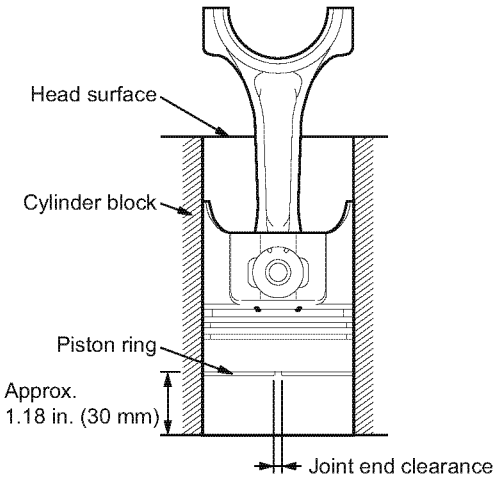
Ring components 001522-01E

in. (mm)

		Standard	Limit
Top ring	Ring groove width	0.0811 to 0.0817 (2.060 to 2.075)	–
	Ring width	0.0776 to 0.0783 (1.970 to 1.990)	0.0768 (1.950)
	Side clearance	0.0028 to 0.0041 (0.070 to 0.105)	–
	End clearance	0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)
Second ring	Ring groove width	0.0797 to 0.0803 (2.025 to 2.040)	0.0843 (2.140)
	Ring width	0.0776 to 0.0783 (1.970 to 1.990)	0.0768 (1.950)
	Side clearance	0.0014 to 0.0028 (0.035 to 0.070)	0.0075 (0.190)
	End clearance	0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)
Oil ring	Ring groove width	0.1581 to 0.1587 (4.015 to 4.030)	0.1626 (4.130)
	Ring width	0.1563 to 0.1571 (3.970 to 3.990)	0.1555 (3.950)
	Side clearance	0.0010 to 0.0024 (0.025 to 0.060)	0.0071 (0.180)
	End clearance	0.0079 to 0.0157 (0.200 to 0.400)	0.0193 (0.490)



Measuring side clearance



Ring joint end clearance measurement 001524-01E

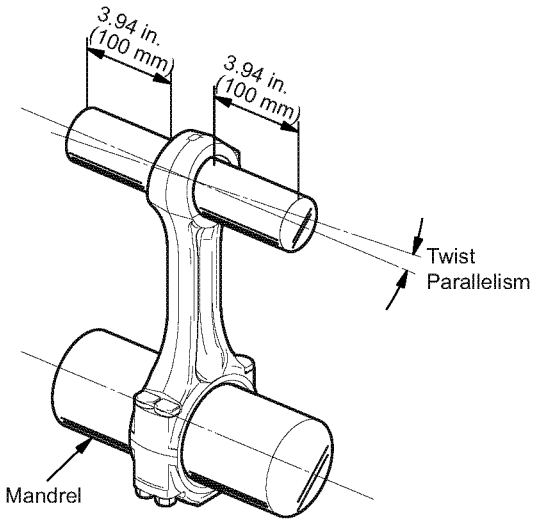
(5) Connecting rod

[1] Appearance inspection

Inspect the portion near the boundary of the chamfered portion and I-beam section of the big and small ends of the connecting rod as well as the portion near the oil hole of the bushing at the small end for cracks, deformation, and discoloration.

[2] Twist and parallelism measurement

Use a connecting rod aligner and measure the twist and bend.



Twist and parallelism measurement 008726-00E

in. (mm)

	Standard dimension	Limit dimension
Twist and parallelism	0.0012 (0.03) or less per 3.94 (100)	0.0031 (0.08)

[3] Rod small end measurement

Measure the pin outside diameter according to (4) [1] described above.

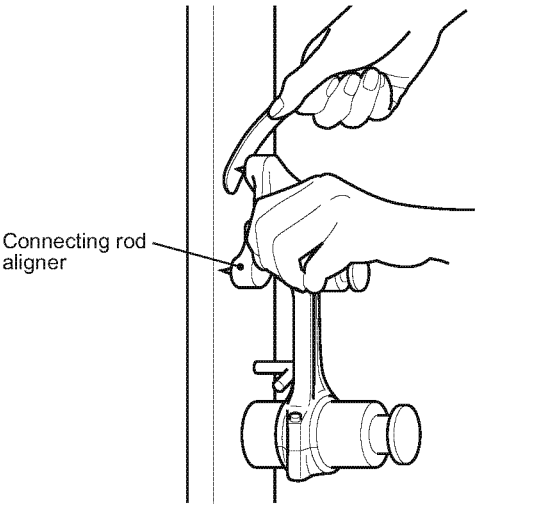
in. (mm)

	Standard	Limit
Piston pin I.D. bushing	1.0246 to 1.0251 (26.025 to 26.038)	1.0263 (26.068)
Piston pin O.D.	1.0231 to 1.0236 (25.995 to 26.000)	1.0220 (25.967)
Oil clearance	0.0010 to 0.0017 (0.025 to 0.043)	0.0040 (0.101)

If the bushing is to be replaced because the oil clearance exceeds the limit, use spare part code No.129100-23910.

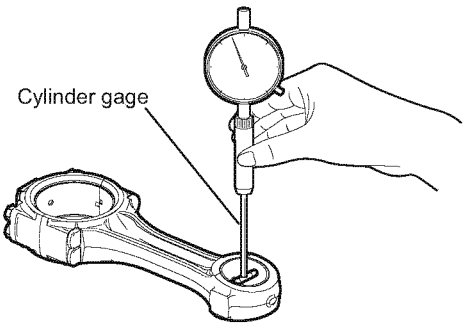
[4] Rod big end measurement

Measure the crankpin and bushing according to (2) [3] described above.



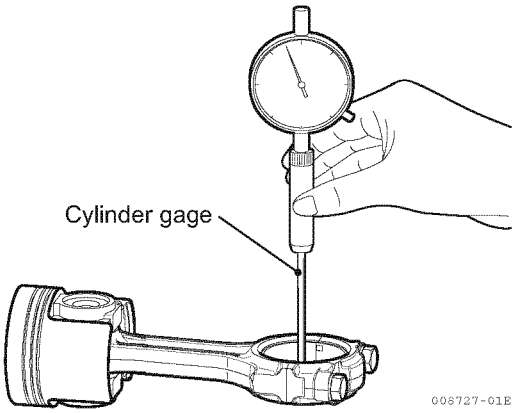
Twist measurement using a connecting rod aligner

011233-00E



Connecting rod small end 008728-00E

Calculate the oil clearance of a crank pin metal and a crank pin from the measured values of the crank pin metal inner diameter and the crank pin outside diameter.
Replace a crank pin metal if the oil clearance becomes about the limit dimension of the below table.
Correct by grinding if unevenly wear, roundness exceeding the limit or insufficient outside diameter is found. Also use an undersized metal.



Rod bushing I.D. measurement

Notice :
When measuring the inside diameter of the rod big end, install the crankpin metals in the rod big end not to mistake the top and bottom of the metals and tighten the rod bolts by the standard torque.

Tightening torque of rod bolt

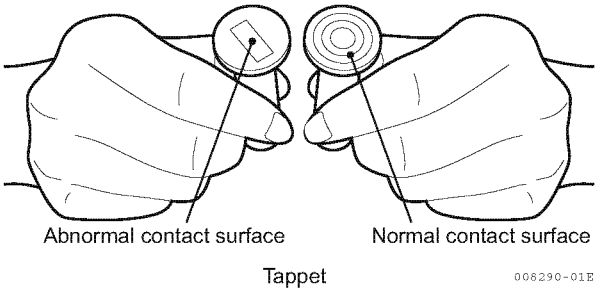
Tightening torque ft•lbf (N•m)	Lubricating oil application (threaded portion, and bearing seat surface)
33 to 36 (44.1 to 49.0)	Lube. oil applied

Standard of rod big end in. (mm)

Item	Standard	Limit
Rod I.D. bushing	1.8879 to 1.8883 (47.952 to 47.962)	1.8859 (47.902)
Crankpin O.D.	1.8898 to 1.8908 (48.000 to 48.026)	-
Metal thickness	0.0587 to 0.0591 (1.492 to 1.500)	-
Clearance	0.0015 to 0.0029 (0.038 to 0.074)	0.0059 (0.150)

(6) Tappet

Mainly check the tappet contact surface with the cam and push rod. Slight surface defects shall be corrected with an oilstone.

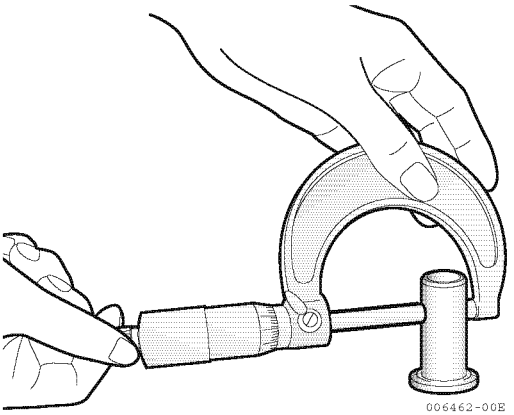


Tappet 008290-01E

[1] Tappet stem outside diameter measurement

in. (mm)

	Standard	Limit
Stem O.D.	0.4715 to 0.4720 (11.975 to 11.990)	0.4707 (11.955)
Tappet hole I.D.	0.4724 to 0.4734 (12.000 to 12.025)	0.4742 (12.045)
Oil clearance	0.0004 to 0.0020 (0.010 to 0.050)	0.0035 (0.090)



006462-00E

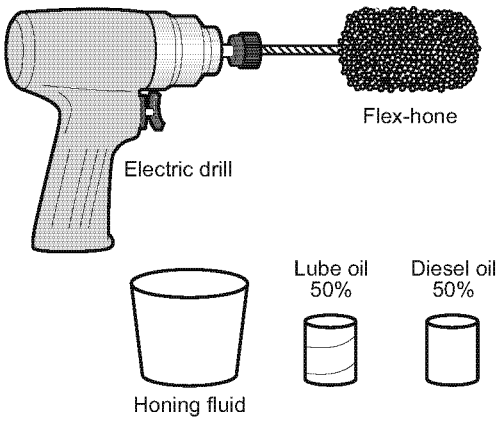
Tappet stem outside diameter measurement

6) Cylinder Bore Correction

[1] Slight uneven worn, flawed, etc. shall be corrected by honing only. If the cylinder is unevenly worn partially, flawed or otherwise damaged and cannot be repaired simply by honing, rebore the cylinder first and then hone. See 5) (1) [3] for the boring dimension.

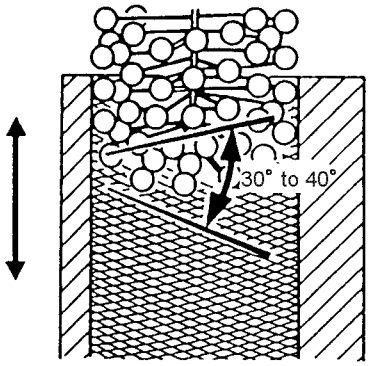
[2] Items to be prepared for honing

- Flex-Hone
- Electric drill
- Honing fluid (50 : 50 mixture of lube oil and diesel oil)



Items to be prepared for honing 014021-00E

[3] Apply the honing fluid to the Flex-Hone and turn the electric drill at 300 to 1200 RPM. Then insert the Flex-Hone into the cylinder bore while turning it, and move it up and down for about 30 sec. to obtain a honing mark with a cross hatch angle of 30 to 40 degrees.



Honing cross hatch

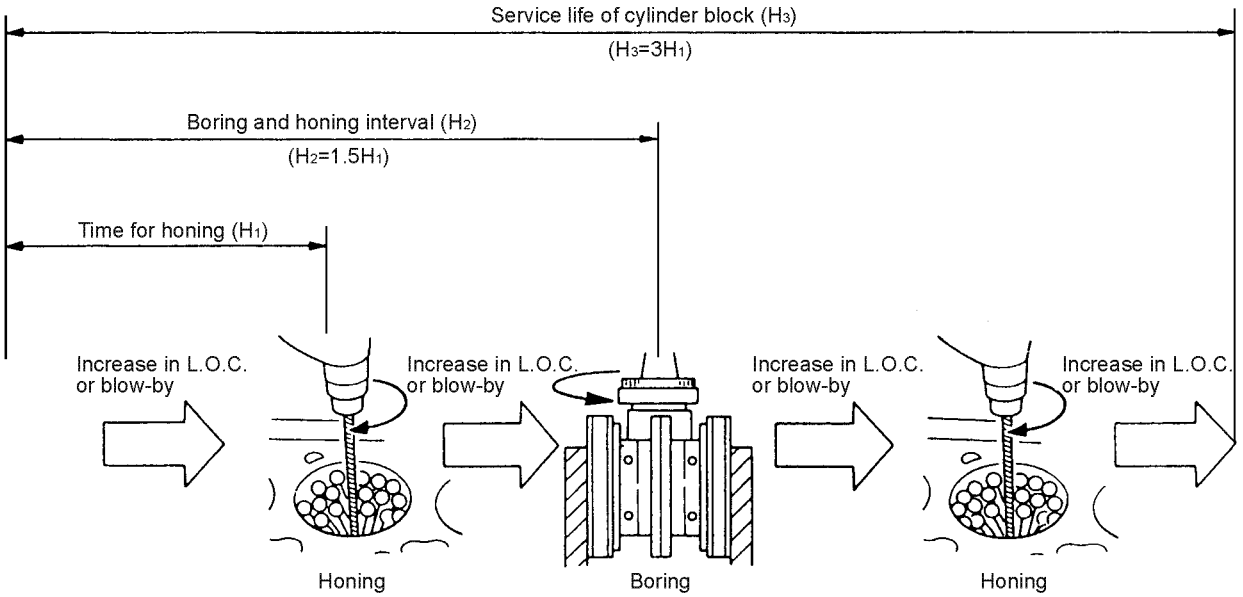
in. (mm)

Cylinder bore after re-boring and honing	3.4744 to 3.4756 (88.250 to 88.280)
Sureface roughness	Rmax 0.04 to 0.14 S (1.0 to 3.5 S)
Roundness (Cylindericity)	0.0004 (0.01) or less

Notice :

- *Avoid faster revolution than 1200 RPM since it may cause breakdown.*
- *Do not insert or extract the Flex-hone in stopped state because the cylinder will be damaged.*

- Cylinder overhaul (reference)



Study if an oversized piston or piston ring is usable

(7) Piston pin bushing replacement

Replace bushing by using the special service tool.

(8) Oil seal replacement

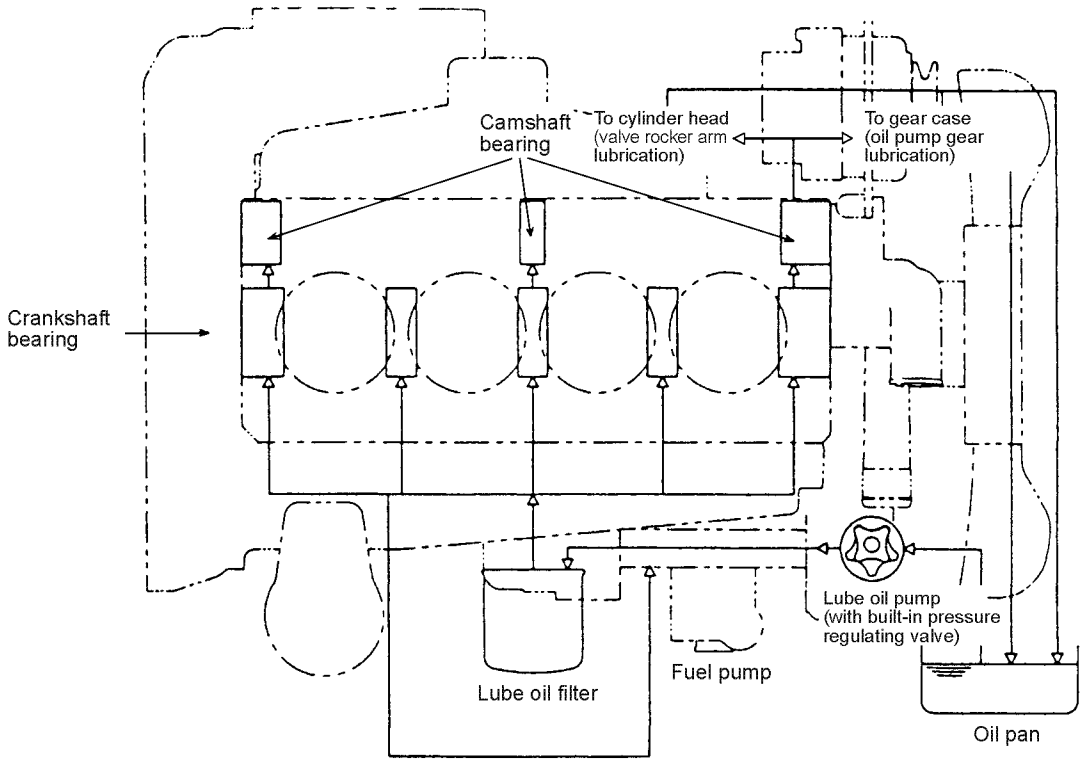
[1] Replace oil seal, when mounting flange is removed. Extract the used oil seal.

[2] Insert a new oil seal with the oil seal insertion tool.

[3] Apply lithium grease.

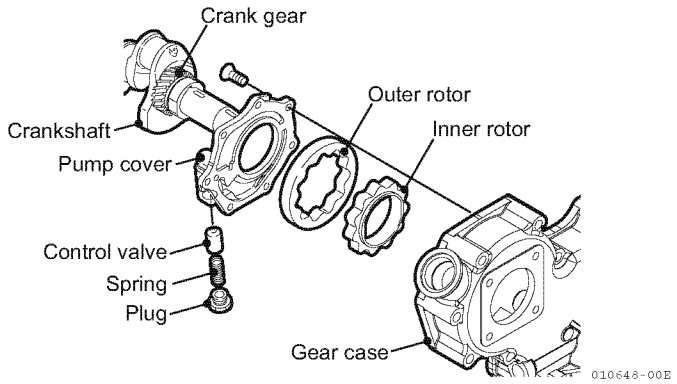
4-5 Lubrication System

4-5-1 Lubrication System Diagram


Camshaft bearing
To cylinder head (valve rocker arm lubrication)
To gear case (oil pump gear lubrication)
Crankshaft bearing
Lube oil pump (with built-in pressure regulating valve)
Lube oil filter
Fuel pump
Oil pan

4-5-2 Trochoid Pump (ViO45-5, ViO55-5: 4TNV88-PBV)

1) Components



2) Disassembly (Reverse the Procedure Below for Assembly)

[1] Loosen the belt, and remove the radiator pulley, fan and V-belt. See 4-4-2 2) 2 in Chapter 4-4.

[2] Remove the crankshaft pulley. See 4-4-3 2) 3 in Chapter 4-4.

[3] Remove the gear case cover. See 4-4-3 2) 4 in Chapter 4-4.

[4] Remove the lubricating oil pump ass'y from the gear case. ***(Point 1)***

[5] Remove the pressure regulating valve from the lubricating oil pump body. ***(Point 2)***

3) Servicing Points

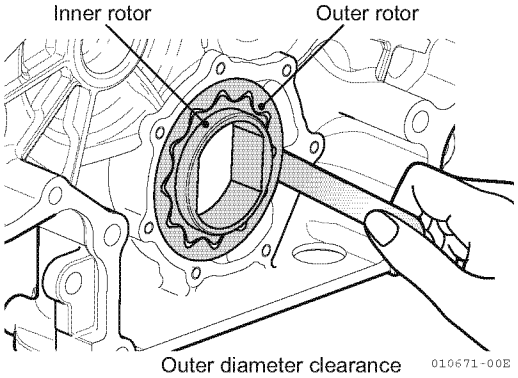
Point 1

Disassemble :

- Check if the pump rotates smoothly and see that there is no play between the shaft and gear, and inner rotor.

Reassemble :

- Install the outer rotor in the gear case so that the punch mark on the end face is seen.
- When replacing the lubricating oil pump, replace the whole ass'y.



Point 2

Disassemble-reassemble :

- Only wash the pressure regulating valve. Disassembly is unnecessary unless any abnormality in operation is detected.

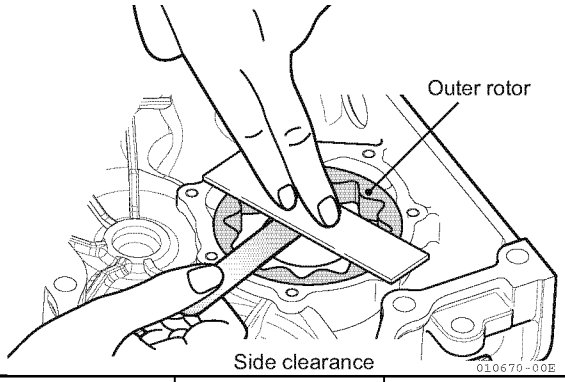
4) Parts Inspection and Measurement

[1] Outer Rotor

- Oil clearance between the outer rotor and inside diameter of the gear case hole.
- Side clearance between outer rotor and gear case hole.

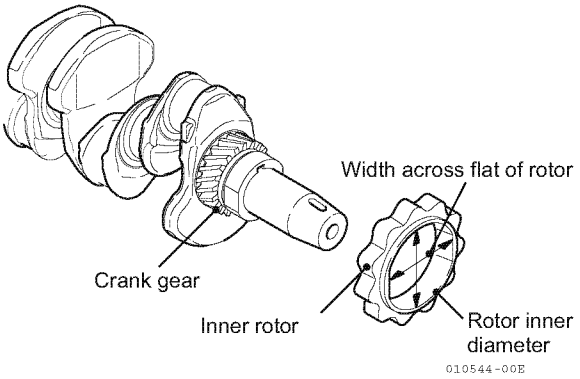
in. (mm)

	Standard	Limit
Oil clearance	0.0047 to 0.0083 (0.12 to 0.21)	0.0118 (0.30)
Side clearance	0.0008 to 0.0028 (0.02 to 0.07)	0.0047 (0.12)



[2] Inner Rotor and Gear Boss Clearance

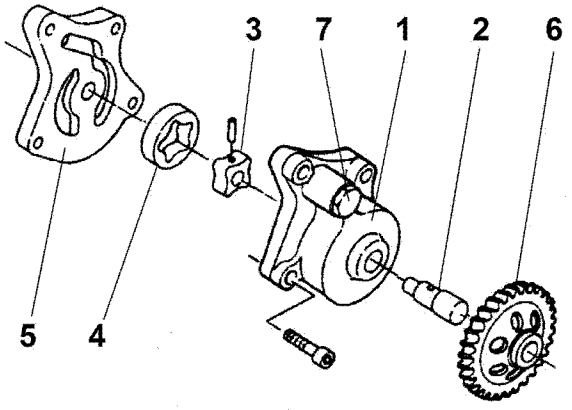
Item	Part	Standard dimension in. (mm)	Standard clearance in. (mm)	Standard clearance limit in. (mm)
Inside clearance of inner rotor	Gear boss diameter	2.089 to 2.093 (53.05 to 53.15)	0.012 to 0.020 (0.3 to 0.5)	0.024 (0.6)
	Rotor inner diameter	2.104 to 2.108 (53.45 to 53.55)		
Width across flat clearance of inner rotor	Width across flat of gear boss	1.947 to 1.959 (49.45 to 49.75)	0.008 to 0.024 (0.2 to 0.6)	0.028 (0.7)
	Width across flat of rotor	1.967 to 1.971 (49.95 to 50.05)		



4-5-3 Trochoid pump (ViO45-5B, ViO55-5B: 4TNV88-BXBV)

1) Components

The oil pump on these model engines is located in the front gear case and is driven by the same gear train that drives the camshaft and fuel injection pump. You must remove the front gear case cover to gain access to the oil pump.



1 – Body
2 – Shaft
3 – Inner rotor
4 – Outer rotor
5 – Cover
6 – Drive gear
7 – Pressure regulator valve

Figure 9-14

2) Disassembly and Reassembly

[1] Disassembly of Oil Pump

⚠ CAUTION

If the oil pump must be replaced, replace it as an assembly only. Do not replace individual components.

Remove cooling fan (Figure 9-15, 3), spacer (Figure 9-15, 2), cooling water pump V-pulley (Figure 9-15, 1), and V-belt.

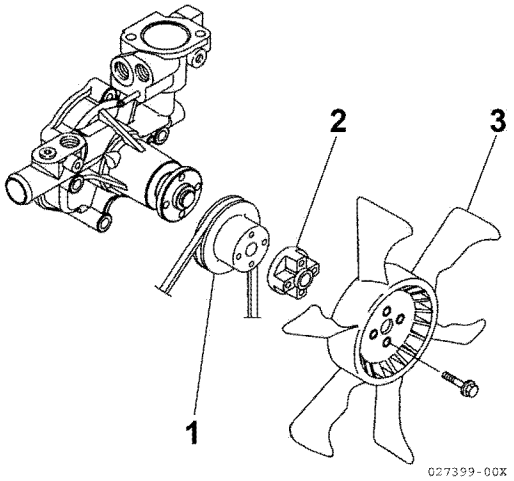


Figure 9-15

1. Remove the crank shaft pulley and gear case cover. See 4-4-3 2) in Chapter 4-4.
2. Remove the lubricating oil pump assembly mounting bolts. Remove the lubricating oil pump assembly (Figure 9-16, 1) from the gear case flange (Figure 9-16, 2).
3. You can remove by hand the lubricating oil pump cover (Figure 9-14, 5) and outer rotor (Figure 9-14, 4).

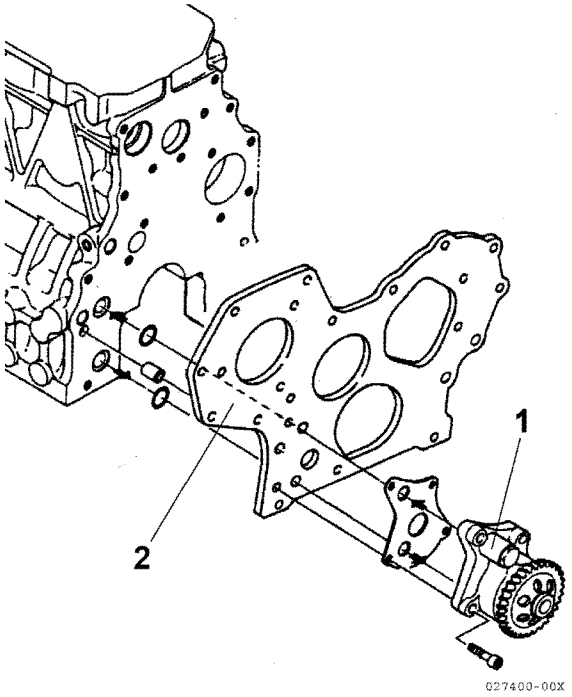


Figure 9-16

[2] Cleaning and inspection

Clean the lubricating oil pump, pressure regulator valve (Figure 9-14, 7), and rotor inserting portion. Check the parts for wear or flaw. Replace the parts with new ones as needed.

⚠ CAUTION

•NEVER overfill the engine with engine oil.
•ALWAYS keep the oil level between the upper and lower lines on the oil cap/dipstick.

[3] Reassembly of Oil Pump

1. Apply clean lubricating oil to the lubricating oil pump body and inner rotor assembly as well as to the outer rotor.
2. Insert the outer rotor into the lubricating oil pump body and inner rotor assembly and install the cover.
3. Replace the packing with new one.
4. Install the lubricating oil pump assembly to the gear case flange by tightening the bolts with the specified torque.
5. Install the gear case cover. For more information, See 4-4-3 2) in Chapter 4-4.
6. Install the crank shaft pulley.

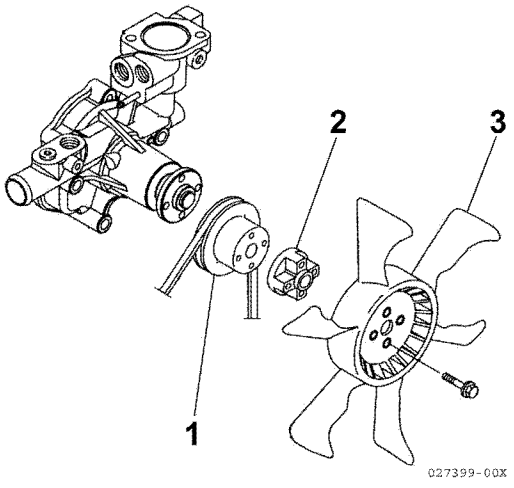


Figure 9-21

7. Install the cooling water pump V-pulley (Figure 9-21, 1), spacer (Figure 9-21, 2), cooling water fan (Figure 9-21, 3).
8. Install the V-belt. Adjust the belt to uniform tensile strength in accordance with the instructions given in 4-3-4 Fan Belt Tension Inspection and Adjustment.

3) Parts Inspection and Measurement

[1] Check Outer Rotor Outside Clearance

Inspect the outside diameter clearance of the outer rotor. To inspect this, insert a feeler gauge between the outer rotor (Figure 9-17, 1) and the lubricating oil pump body (Figure 9-17, 2).

Record the measurement(s) and refer to Section "3-2 1) Nominal and Allowable Values".

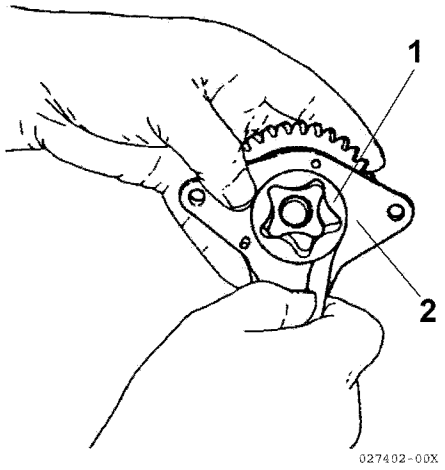


Figure 9-17

[2] Rotor to Inner Rotor Tip Clearance

Inspect the tip clearance between the outer and inner rotors. To inspect this, insert a feeler gauge between the inner rotor tooth tip (Figure 9-18, 1) and the outer rotor tooth tip (Figure 9-18, 2), and measure the clearance.

Record the measurement(s) and refer to Section "3-2 1) Nominal and Allowable Values".

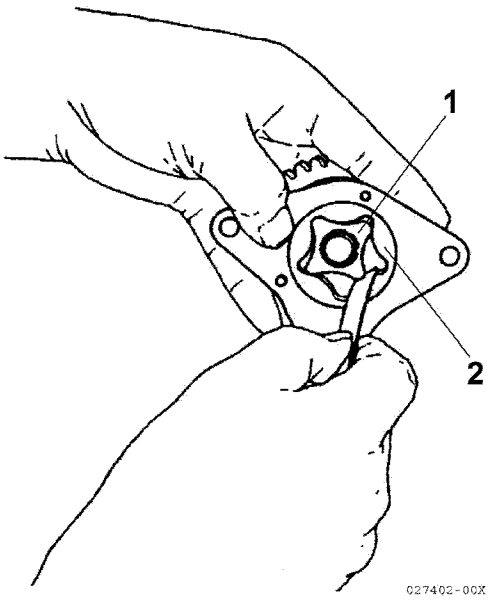


Figure 9-18

[3] Outer Rotor Side Clearance

Inspect the side clearance between the lubricating oil pump body and the outer rotor. To measure the side clearance, use a straight edge and feeler gauge (as shown in Figure 9-19 or a depth micrometer.

Record the measurement(s) and refer to Section "3-2 1) Nominal and Allowable Values".

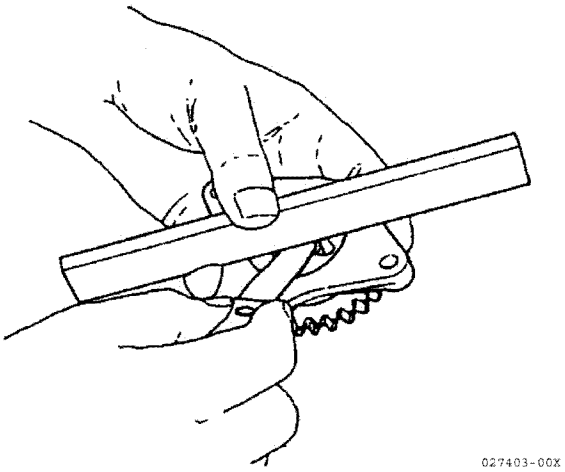


Figure 9-19

[4] Rotor Shaft Clearance

Inspect the rotor shaft clearance. Measure the outside diameter of the rotor shaft (Figure 9-20, 1) and the inside diameter of the cover.

Determine the clearance by subtracting the outside diameter of the rotor from the inside diameter of the cover.

Record the measurement(s) and refer to Section "3-2 1) Nominal and Allowable Values".

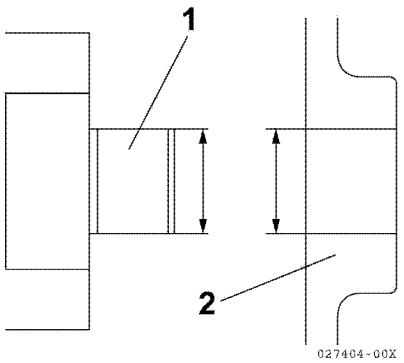
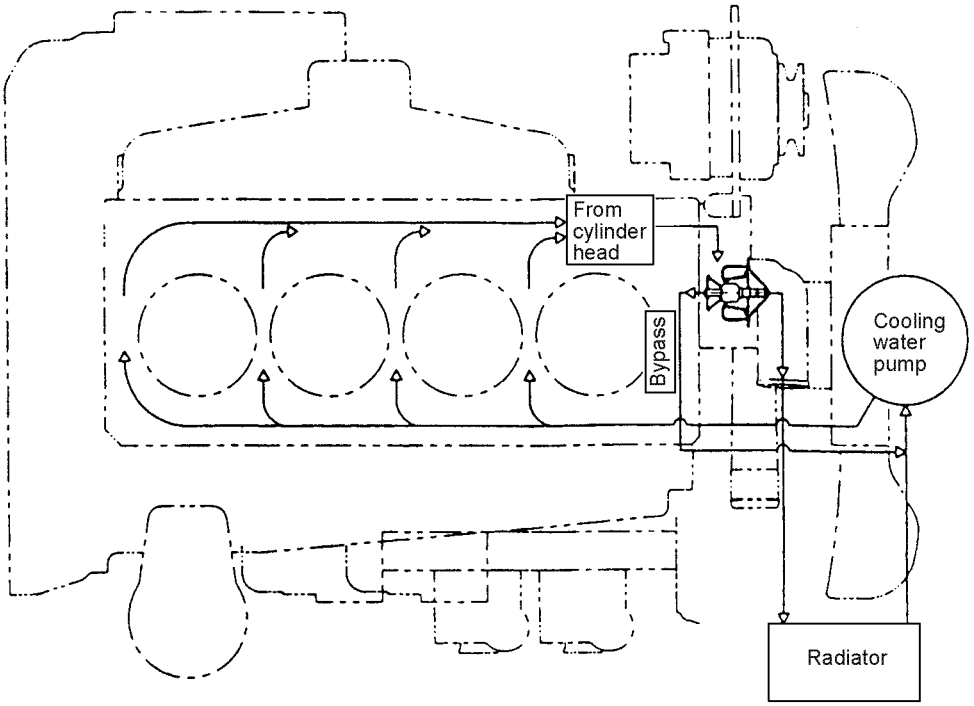


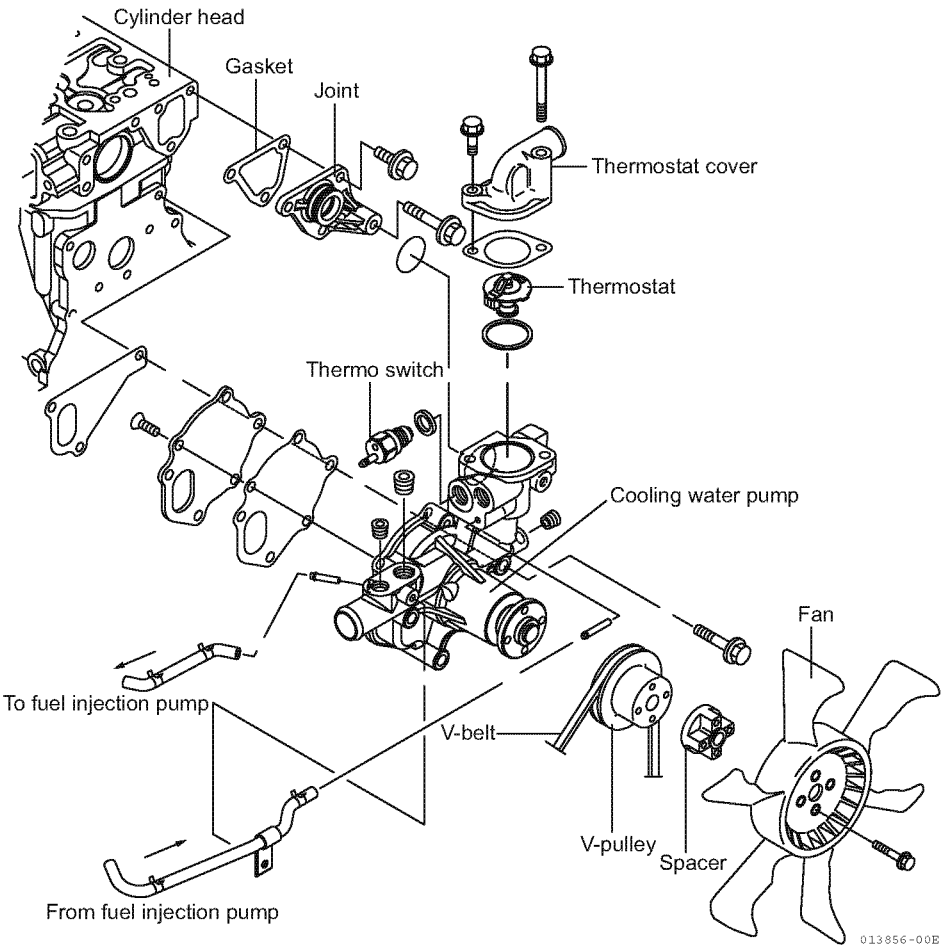
Figure 9-20

4-6 Cooling System

4-6-1 Cooling Water System



4-6-2 Cooling Water Pump Components



4-6-3 Disassembly (Reverse the Procedure Below for Assembly)

[1] Remove the alternator. See 4-4-2 2) 1 in Chapter 4-4.
[2] Remove the fan, V-belt and pulley. See 4-4-2 2) 2 in Chapter 4-4.
[3] Remove the thermostat cover. See 4-4-2 2) 3 in Chapter 4-4.
[4] Remove the cooling water pump. ***(Point 1)***
[5] Remove the thermostat. ***(Point 2)***

4-6-4 Servicing Points

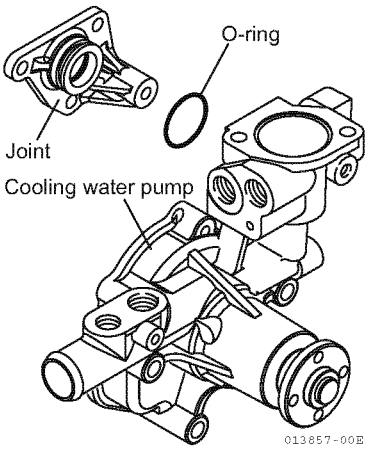
Point 1

Disassemble-Reassemble :

- Check to see that the cooling water pump bearing is free from abnormal noise, sticking or play and water leakage from the bearing. If replacement is necessary, replace the whole cooling water pump ass'y.

Notice :

Replace the O-ring of the cooling water pump with new one when disassembling. And, be sure to use the special O-ring for each engine model, because the material is different, although the dimension is the same as a commercial part. (Refer to the right figure.)



Point 2

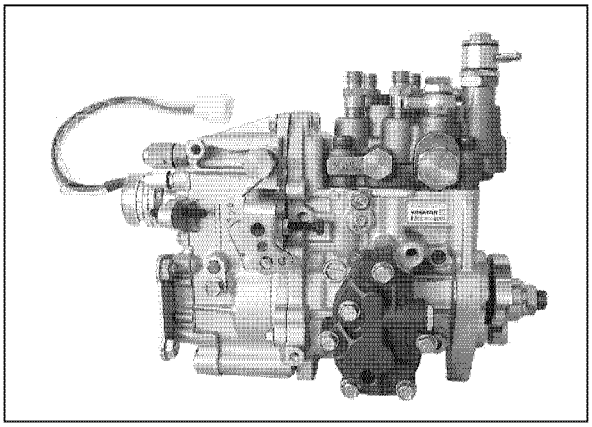
Disassemble :

- Check the thermostat function. See 4-3-8 (1) [1] in Chapter 4-3 for the inspection method.

4-7 Fuel Injection Pump / Governor

Only the outline of the MP fuel pump is explained in this chapter. Refer to the MP pump service manual of the separate volume for the disassembly and assembly.

4-7-1 Introduction



It is described about the features of the fuel injection pump, YDP-MP, manufactured by Yanmar, disassembly, assembly and adjustment procedure.

Fuel injection pump is the most important equipment, which is enable to make the sensitive adjustment according to the variable load of the engine.

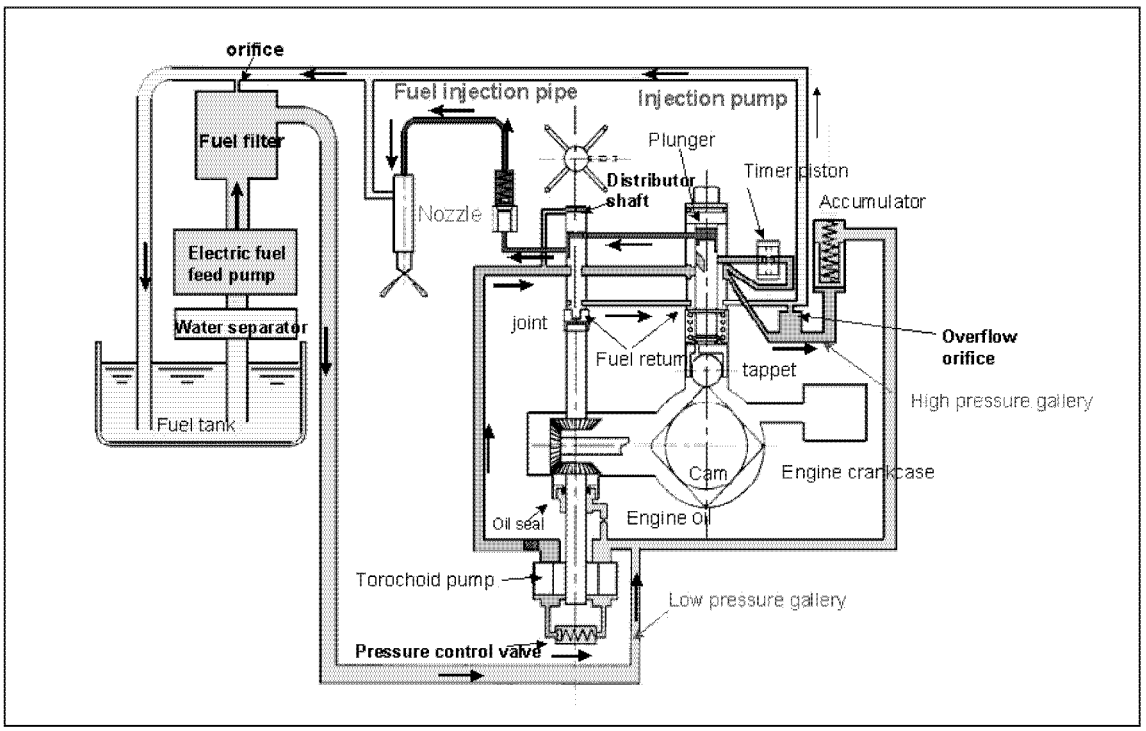
Therefore all of the parts are required not only very precise machining but also finest, assembling with top level.
The careful arrangement of keeping off the dust and the rust when disassemble, adjustment and reassemble of the fuel injection pump is made in the market.

Yanmar YDP-MP Pump is a distributor type pump which is unified of Mono-plunger, a distributing shaft, a hydraulic head which equipped the delivery valve for each cylinder, pump housing which has a cam shaft internally and governor.
The fuel, which is pressurized by the up and down movement of the plunger driven by the cam-rotation, is supplied through the distributor shaft, which is rotating accordingly.

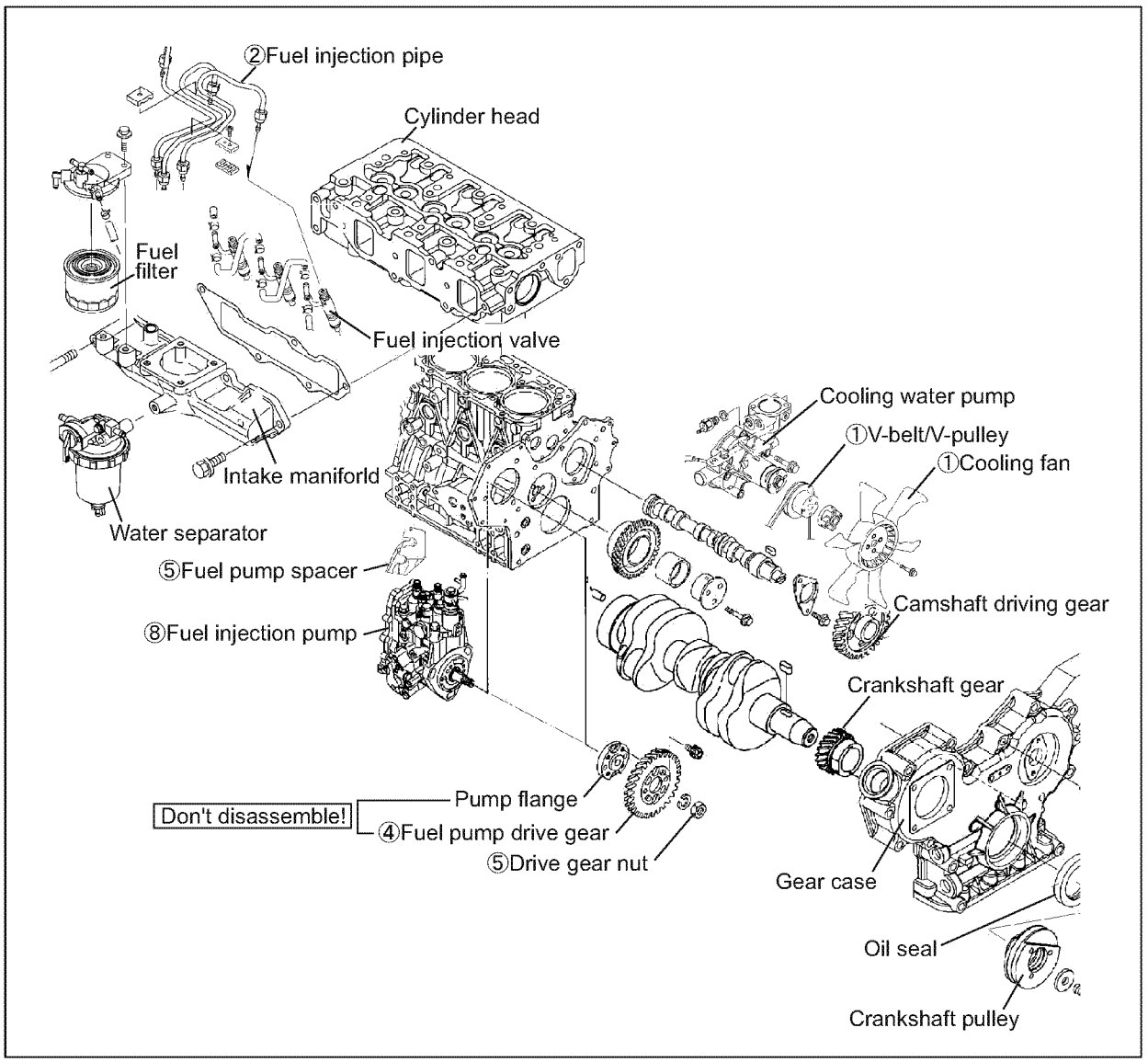
There are a model YDP-MP2 and a model YDP-MP4, and plunger diameter and fuel cam speed are different.

4-7-2 Fuel Injection Pump

1) Fuel System Diagram



2) External View and Components



3) Disassembly Procedure :

Disassembly from the engine body

(1) Remove the cooling fan, pulley and V-belt.

(2) Remove the fuel injection pipe, fuel oil piping, fuel return pipe and rear stay. See point 1 of 5).

(3) Remove the fuel injection pump cover (the cover of the drive gear).

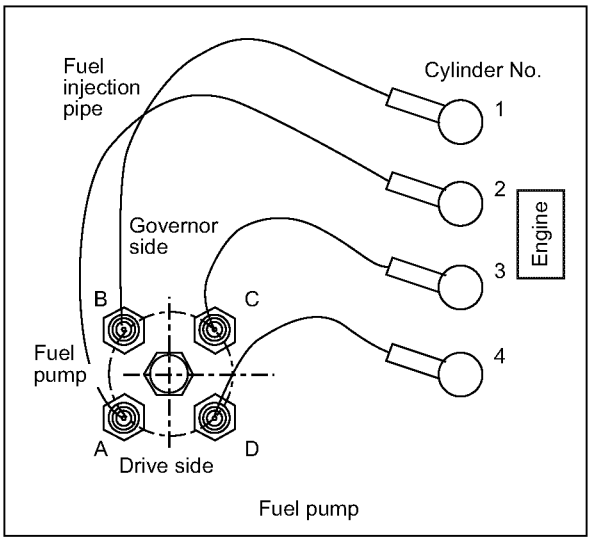
(4) Make ID marks on the gearing part of the pump drive gear and the idle gear with paint and so on. See Point 2 of 5).

(5) Loosen a fuel pump drive gear nut, and remove a pump drive gear from the fuel pump by using a gear puller. See Point 3 of 4-4-3 4).

(6) Remove a drive gear nut carefully not to drop it to the inside of the gear case.

(7) Record the installation angle of the fuel pump precisely by using a mark-off line and a sticker. See 4-3-7.

(8) Remove the fuel injection pump. See Point 3 of 5).



4) Assembly Procedure

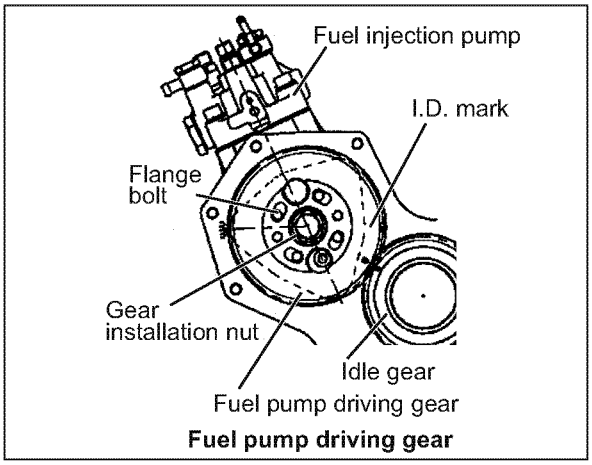
Reverse the disassembly procedure and adjust the fuel injection timing finally. See (4) of 4-3-7.

5) Servicing Points

Point 1

Disassemble :

- Block an entrance with the tape so that trash may not enter the fuel injection pipe and the fuel injection pump.



Fuel pump driving gear

Point 2

Disassemble :

- After putting the I.D. marks on the gearing part of the pump drive gear and the idle gear with paint and so on, remove the gear installation nut.

Notice :

Don't remove four flange bolts.

Reassemble :

- Reassemble the pump driving gear while checking the I.D. marks on the driving gear and idle gear.

Tightening torque of the gear installation nut

ft•lbf (N•m)	Lubricating oil application (thread portion, and seat surface)
58 to 65 (78 to 88)	Not applied

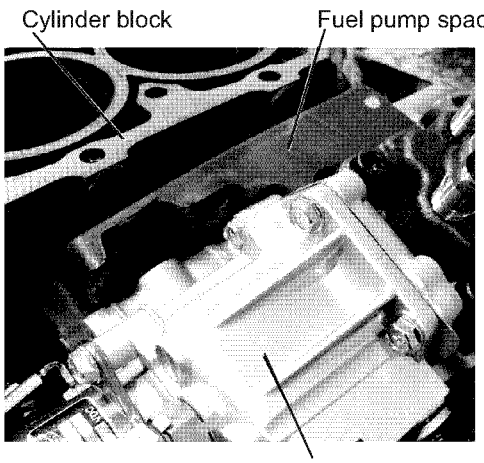
Point 3

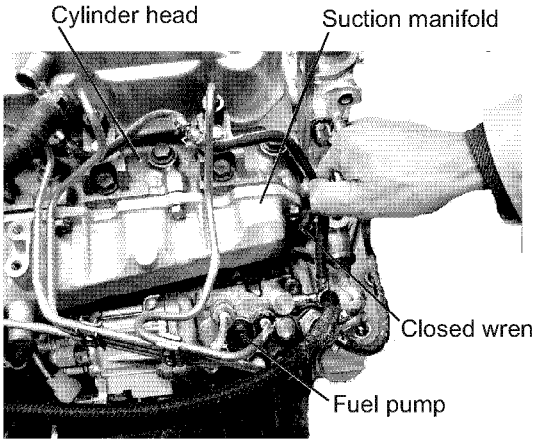
Disassemble :

There is an acoustic material part to name as fuel pump spacer between the fuel pump and the cylinder block. Loosen fuel pump installation bolts with a closed wrench when disassembling a fuel pump.

Notice :

An intake manifold may obstruct the disassembly of the fuel pump by the engine model. Remove the fuel pump after removing the intake manifold first.





Disassembling a fuel pump

Reassemble :

When installing a fuel pump on the gear case, put a fuel pump spacer between the cylinder block and the pump.

See the Service Manual of "Fuel Injection Equipment (Model YPD-MP2 / YPD-MP4 series)" for further information of the fuel injection pump.

4-8 Electrical Equipment

4-8-1 Starter Motor

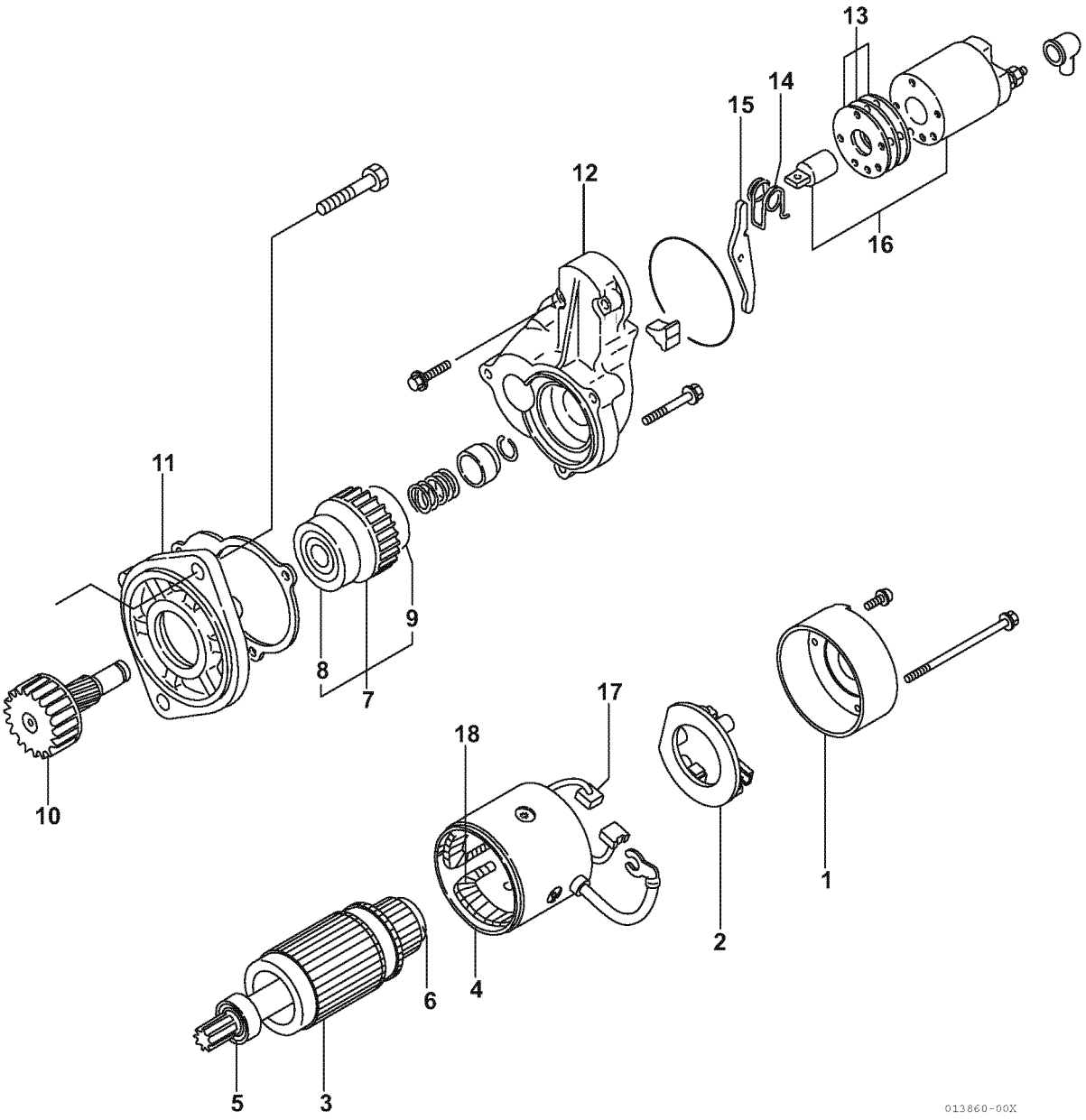
To start the engine, the starter motor rotates the ring gear installed on the engine flywheel with the pinion gear engaged with the ring gear so that the force generated by the rotation exceeds the resistance including the engine compression pressure and all frictional force. The starter motor consists of the following major parts : a motor which generates torque ; a pinion which transmits the torque to the engine ring gear ; a clutch ; and a magnetic switch which pushes out the pinion and turns on and off the principal current.

1) Specifications and Service Data

Yanmar code				129136-77011
Applicable model				4TNV88-PBV
Starter motor model				S13-332
Nominal output / Weight			kW / lbs. (kg)	2.3 / 11.7 (5.3)
Rotation direction (Viewed from pinion side)				Clockwise
Engagement method				Magnetic shift
No load	Terminal voltage / Current		V / A	11 / Þ140
	Speed		rpm	ÿ4100
Load characteristics	Terminal voltage / Current		V / A	2.5 / 1050
	Torque / Speed		ft•lbf (N•m) / rpm	ÿ18.5 (25.0)
Clutch type				Overrunning clutch
Pinion coming out voltage			V	Þ8.7
Pinion DP or module / Number of pinion teeth				DP10 / 15
Brush	Standard spring force		lbs. (N)	22.9 to 28.8 (31 to 39)
	Standard height / Wear limit		in. (mm)	0.59 (15.0) / 0.35 (9.0)
Magnetic switch resistance at 68 °F (20 °C)	Series coil / Shunt coil		Ω	0.37 / 0.62
Commutator	Outside diameter	Standard / Wear limit	in. (mm)	Ø1.43 (36.5) / Ø1.40 (35.5)
	Difference between max. and min. dia.	Correction limit / Precision		0.0079 (0.2) / 0.0012 (0.03)
	Mica undercut	Correction limit / Precision		0.00787 (0.2) / 0.02 to 0.03 (0.5 to 0.8)
Standard diameters	Armature side bearing	Shaft diameter / Bearing inside diameter	in. (mm)	Armature 6903Z / Bearing (F/R) 608Z
	Pinion clutch bearing	Shaft diameter / Bearing inside diameter		Gear case 608ZZ / Bearing (F/R) 608ZZ
	Pinion sliding section	Shaft diameter / Bearing inside diameter		6004ZZ
	Pinion side bearing	Shaft diameter / Bearing inside diameter		6004ZZ
Gap between pinion and pinion stopper			in. (mm)	0.01 to 0.06 (0.3 to 1.5)

2) Construction of Starter Motor

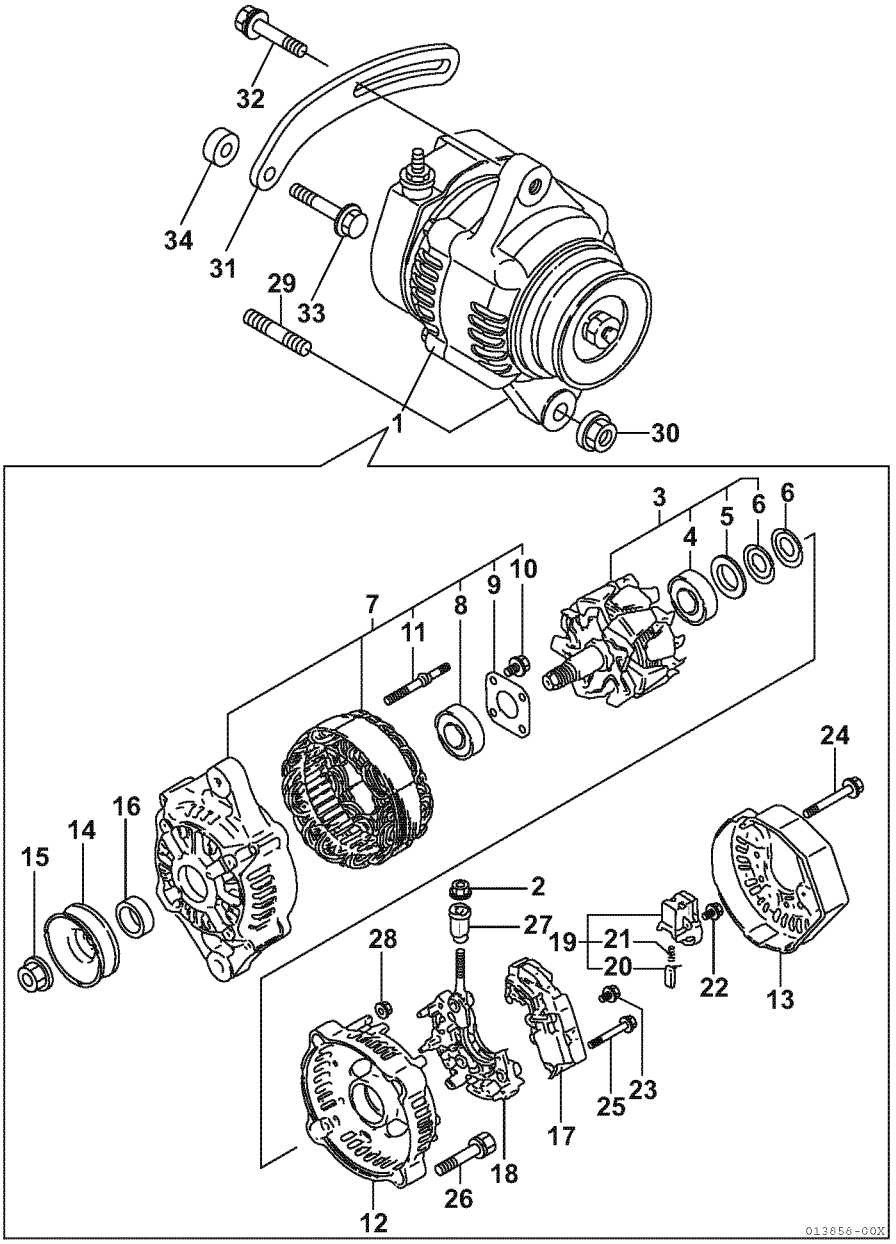
No.	Part	No.	Part
1	Rear cover	10	Pinion gear
2	Brush holder	11	Gear case
3	Armature	12	Center housing
4	Yoke	13	Dust cover
5	Ball bearing	14	Torsion spring
6	Ball bearing	15	Shift lever
7	Pinion clutch	16	Magnetic switch
8	Ball bearing	17	Brush
9	Ball bearing	18	Coil



4-8-2 Alternator

The alternator is a revolving-field type three-phase AC generator. The AC electricity generated by the alternator is converted to DC through the full-wave rectification by the diode and is stored in the battery.
The alternator contains a regulator using an IC and can detect the battery voltage to adjust the generated voltage in the alternator.

1) Components

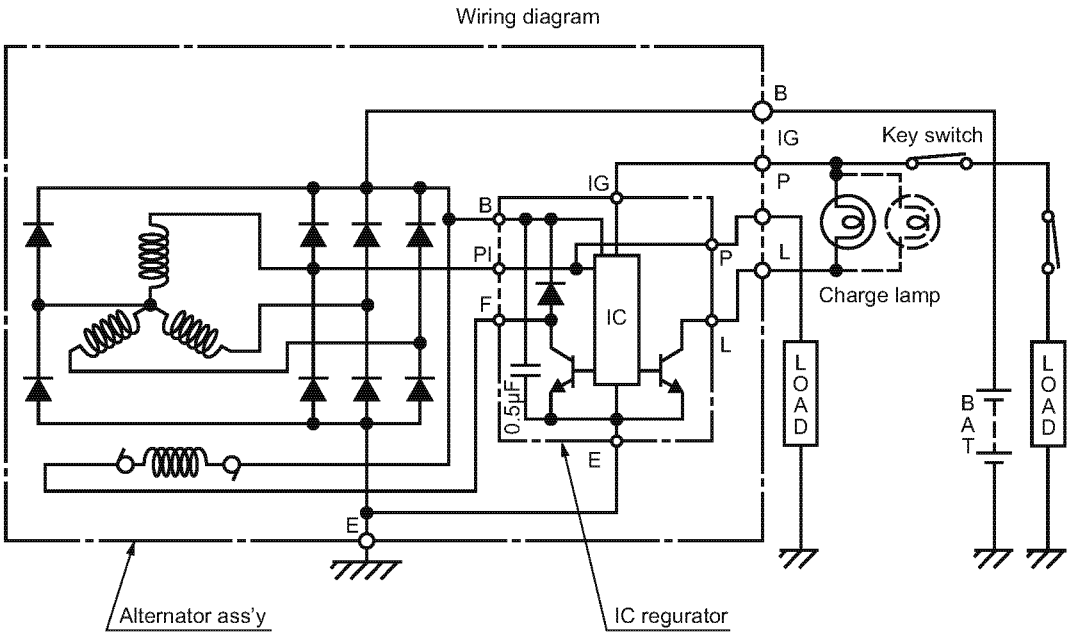


No.	Part	No.	Part	No.	Part	No.	Part
1	Alternator	10	Cap screw	19	Brush holder	28	Nut
2	Nut	11	Stud bolt	20	Brush ass'y	29	Stud bolt
3	Rotor ass'y	12	Rear frame ass'y	21	Spring	30	Flange nut
4	Ball bearing	13	Rear end cover	22	Cap screw	31	Bolt tension adjuster
5	Bearing cover	14	Pulley	23	Cap screw	32	Adjuster bolt
6	Washer	15	Nut	24	Bolt	33	Plated bolt 8×45
7	Drive frame ass'y	16	Collar	25	Cap screw	34	Spacer
8	Ball bearing	17	Regulator ass'y	26	Bolt		
9	Retainer plate	18	Holder	27	Insulation bushing		

2) Specifications

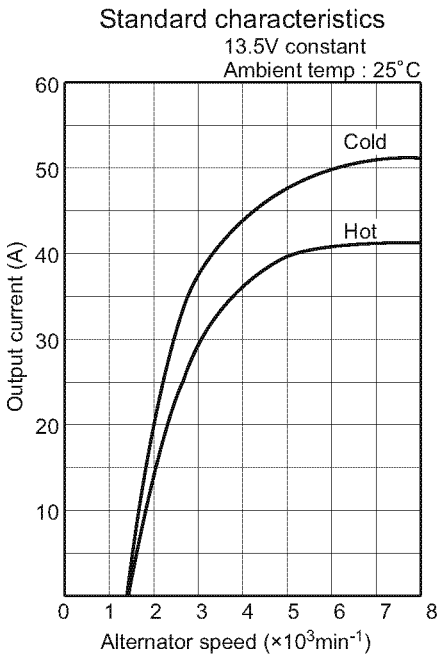
Alternator model	-	ACFA68
Yanmar P/#	-	129423-77200
Battery voltage	V	12
Nominal output (at 13.5 V in hot condition)	A	40
Rated speed	min^{-1}	5000
Operating speed	min^{-1}	1350 to 18000
Ground polarity	-	Negative
Rotation direction (viewed from pulley side)	-	Clockwise
Regulation method		IC Regulator
Weight	lb (kg)	6.2 (2.8)
Pulley diameter	in. (mm)	2.72 (69.2)
V-belt type	-	A type

3) Connections



4) Standard Output Characteristics

The standard performance is shown to the right.



Note:

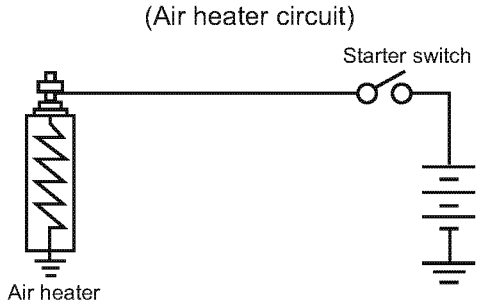
- *Be careful not to connect wrong terminals and short circuit.*
- *Do not directly connect the terminals of IG to L. Always install the charge lamps between them.*
- *No load between the terminals L and E.*
- *Do not disconnect the terminal B and that of the battery while the alternator is running.*
- *Cut-off the battery switch while the alternator is not running.*
- *Tighten each terminal to 1.25 to 1.70 ft•lb (1.7 to 2.3 N•m)*

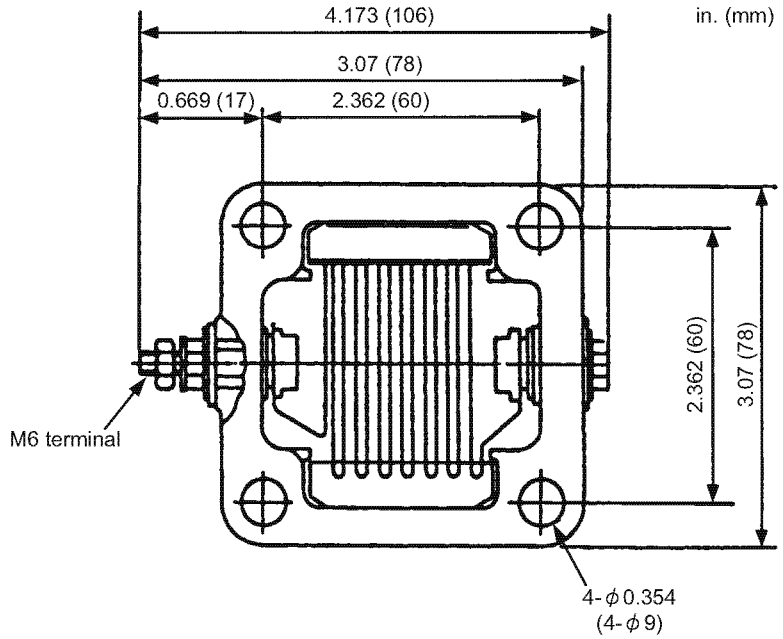
4-8-3 Air Heater

The air heater installed on the intake manifold is a starting aid in cold weather, which serves to warm the air and send it to the combustion chamber to start the engine easily at low ambient temperature.
The air heater is operated to warm the sucked air by setting the starter switch key to "AIR HEATER" position and supplying electricity for about 10 to 15 seconds.
If electricity is supplied to the air heater for more than 15 seconds, this will cause breaking of the heater lead or battery trouble.

Specifications

Rated output	400 W
Rated current	33.3 A
Rated voltage	DC12 V
Rated operating time	30 sec. max.
Ground polarity	Negative





CHAPTER 5

HYDRAULIC SYSTEM

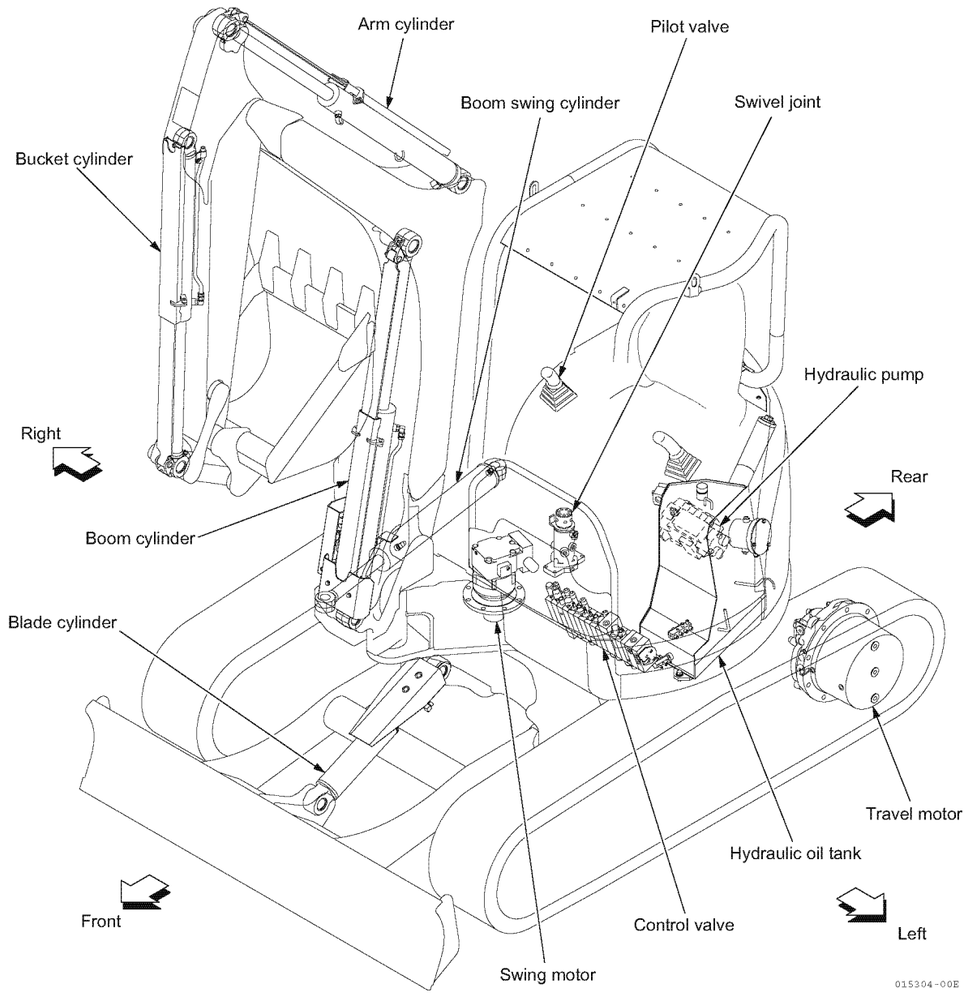
5-1 Outline 5-1-1
5-1-1 Control Valve Operation 5-1-4
5-1-2 Additional Operation of Control Valve 5-1-6
5-2 Hydraulic Circuit Schematic 5-2-1
5-2-1 Quick Coupler 5-2-1
5-2-2 W/O Quick Coupler 5-2-2
5-3 Circuit Operation 5-3-1
5-3-1 Boom 5-3-1
5-3-2 Arm 5-3-3
5-3-3 Bucket 5-3-5
5-3-4 Swing 5-3-7
5-3-5 Boom Swing 5-3-9
5-3-6 Blade 5-3-11
5-3-7 Travel 5-3-13
5-3-8 Non-Deviation Travel
(with Boom, Arm or Boom Swing Operation) 5-3-15
5-3-9 Non-Deviation Travel (with Bucket Operation) 5-3-17
5-3-10 Simultaneous Operation of Boom Up and Arm Retract 5-3-19
5-3-11 Simultaneous Operation of Boom Up and Bucket 5-3-21
5-3-12 Simultaneous Operation of Boom Up and Swing 5-3-23
5-3-13 Simultaneous Operation of Arm and Bucket 5-3-25
5-3-14 Hydraulic P.T.O. 5-3-27
5-3-15 Quick Coupler 5-3-29
5-4 Pressure Adjustment 5-4-1
5-4-1 Relief Valves 5-4-1
5-4-2 Swing Brake Valve 5-4-3
5-4-3 Cut-Off Valve 5-4-4

5. HYDRAULIC SYSTEM

5. Hydraulic System

5-1 Outline

The hydraulic system consists of an engine, variable displacement piston pumps, a gear pump, a control valve, a boom cylinder, an arm cylinder, a bucket cylinder, a boom swing cylinder, a blade cylinder, a swing motor, a swivel joint, two travel motors, 2 way valve and a hydraulic oil tank. The oil discharged from the variable displacement piston pumps and that from the gear pump flow to the actuators through the control valve.
The hydraulic pilot control system comprises a pilot pump, a cut-off valve mounted on the hydraulic pump and two pilot valves. The oil discharged from the pilot pump flows into the pilot ports of the control valve through the cut-off valve, the pilot valves and 2 way valve to control the valve spool movement in proportion to the pressure at the port.



5. HYDRAULIC SYSTEM

1) Hydraulic Pump

The variable displacement piston pumps, the gear pump and the pilot pump are linked to the flywheel of the engine through the coupling. The number of revolutions of each hydraulic pump is identical to the engine speed.

cu. in. (cu. cm) / rev

No.	Pump		ViO45-5 ViO45-5B	ViO55-5 ViO55-5B
1	Piston pump	P1	1.02 (16.8)	
2	Piston pump	P2	1.02 (16.8)	
3	Gear pump	P3	1.02 (16.8)	
4	Pilot pump	P4	0.30 (4.9)	

2) Oil Flow

(1) Piston pumps P1 and P2, and gear pump P3

The pumps take in oil through the suction filter from the hydraulic oil tank and discharge it. The discharged oil flows to the ports P1, P2 and P3 of the control valve and returns from the ports T1 and T2 to the hydraulic oil tank through the return filter. This circulation is repeated.

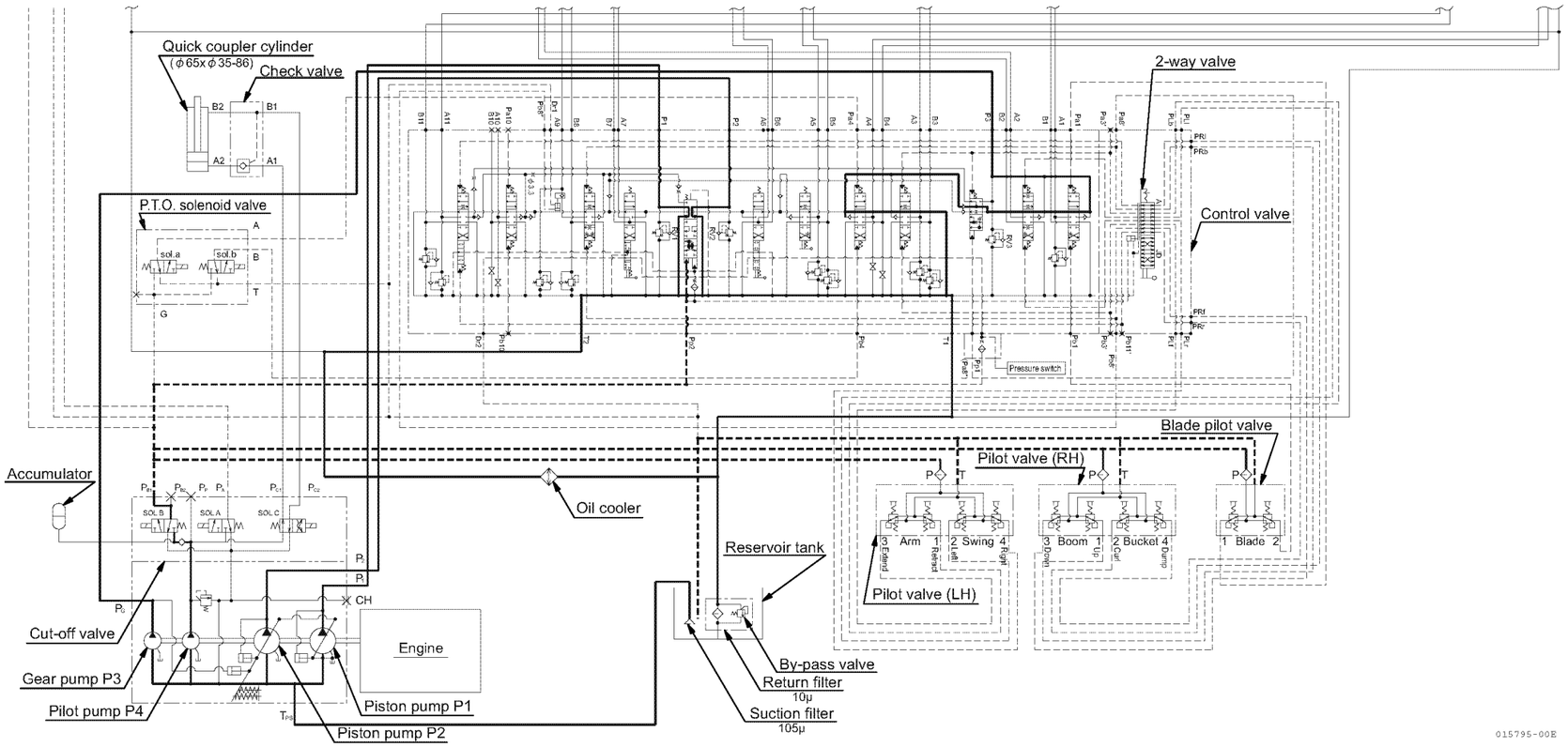
The bypass valve in the return filter opens at a differential pressure of 21.3 PSI (0.147 MPa).

(2) Pilot pump P4

The oil from the pilot pump P4 flows back to the hydraulic oil tank through the port B1 of the cut-off valve integrated into the pump, the pilot valves, the blade control pilot valve and the return filter.

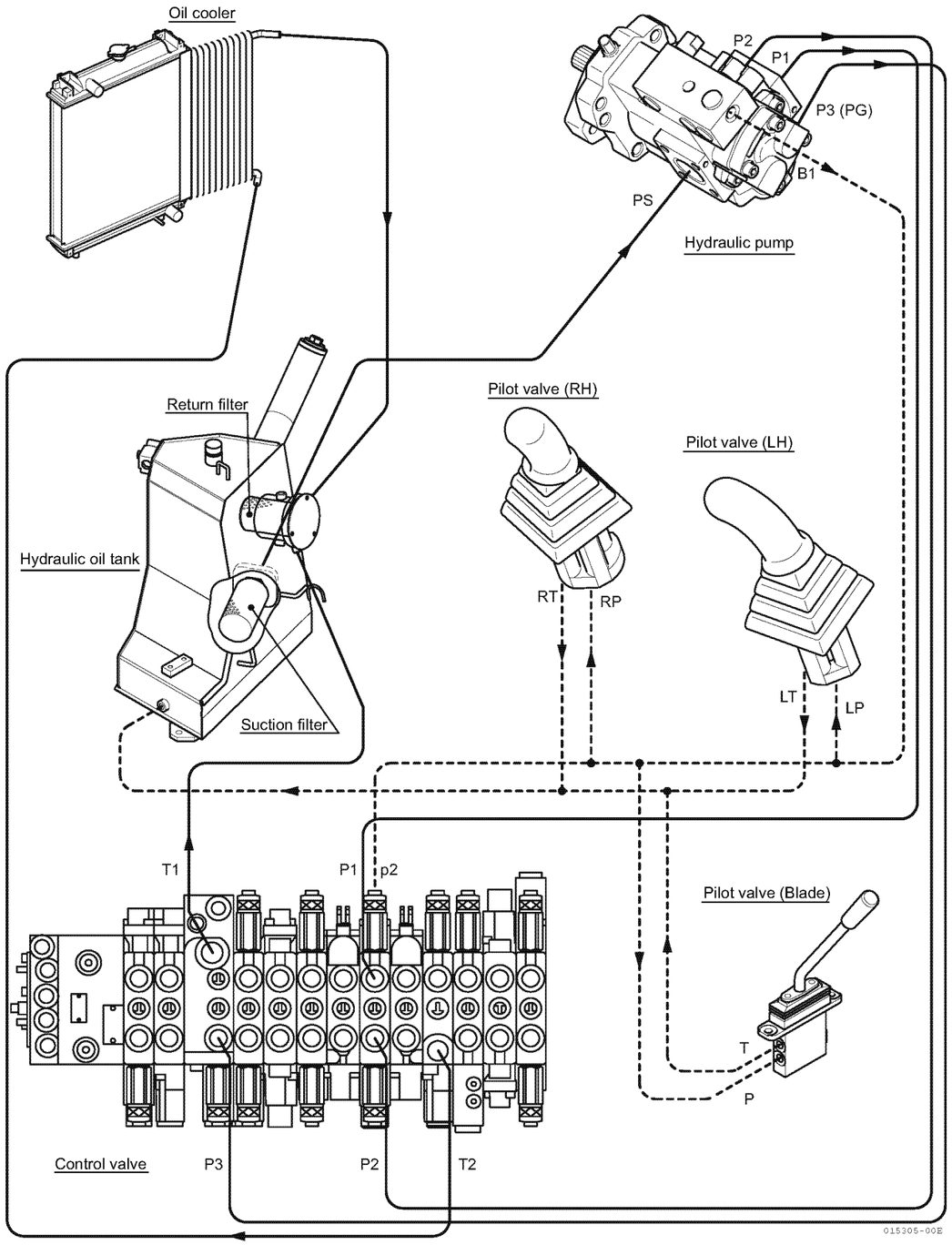
3) System Relief Valve

The system relief valves RV1, RV2 and RV3 of the control valve control the discharge pressure of the pumps.



015795-00E

5. HYDRAULIC SYSTEM



5. HYDRAULIC SYSTEM

5-1-1 Control Valve Operation

1) Oil Flow from Hydraulic Pump

(1) Piston pump P1

The oil from the piston pump P1 is fed to the right travel motor and the boom and bucket cylinders through the port P1 of the inlet section, the travel (R), boom and bucket sections.

(2) Piston pump P2

The oil from the piston pump P2 is fed to the left travel motor, the boom swing and arm cylinders and the P.T.O. through the port P2 of the inlet section, the travel (L), boom swing, arm and P.T.O. sections.

(3) Gear pump P3

The oil from the gear pump P3 flows through the port P3 of the parallel-flow divider to the swing and blade sections, and also to the arm and P.T.O. sections to be combined with the oil from the piston pump P2.

2) Simultaneous Operation of Boom and Bucket

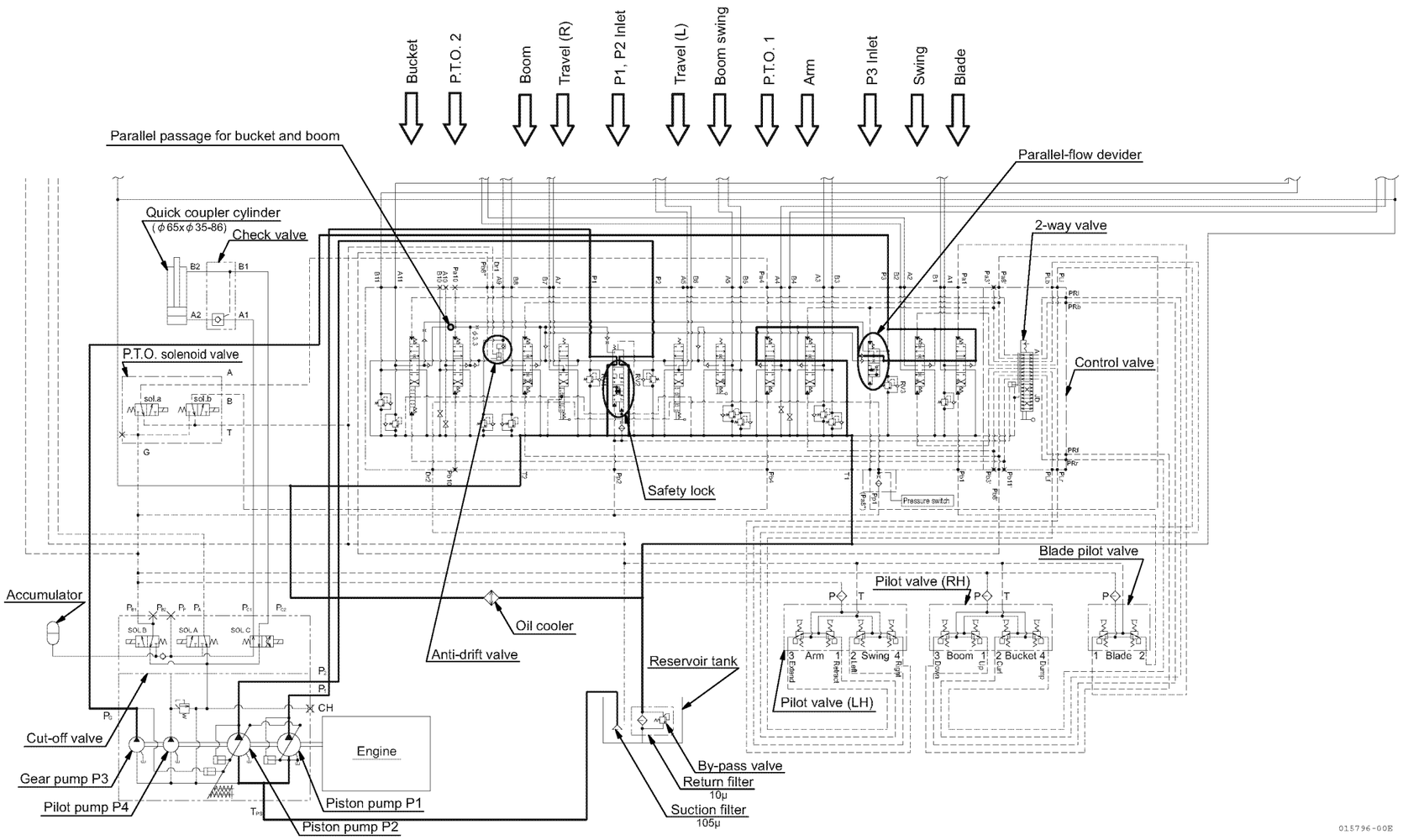
A parallel passage is provided for the boom and bucket sections. The parallel passage has a throttle in the bucket section, so that the oil can flow to the boom section more smoothly than to the bucket section when the boom is given a heavier load. Therefore, the boom and the bucket can be operated simultaneously.

3) Anti-Drift Valve (Reduction of Boom Drifting)

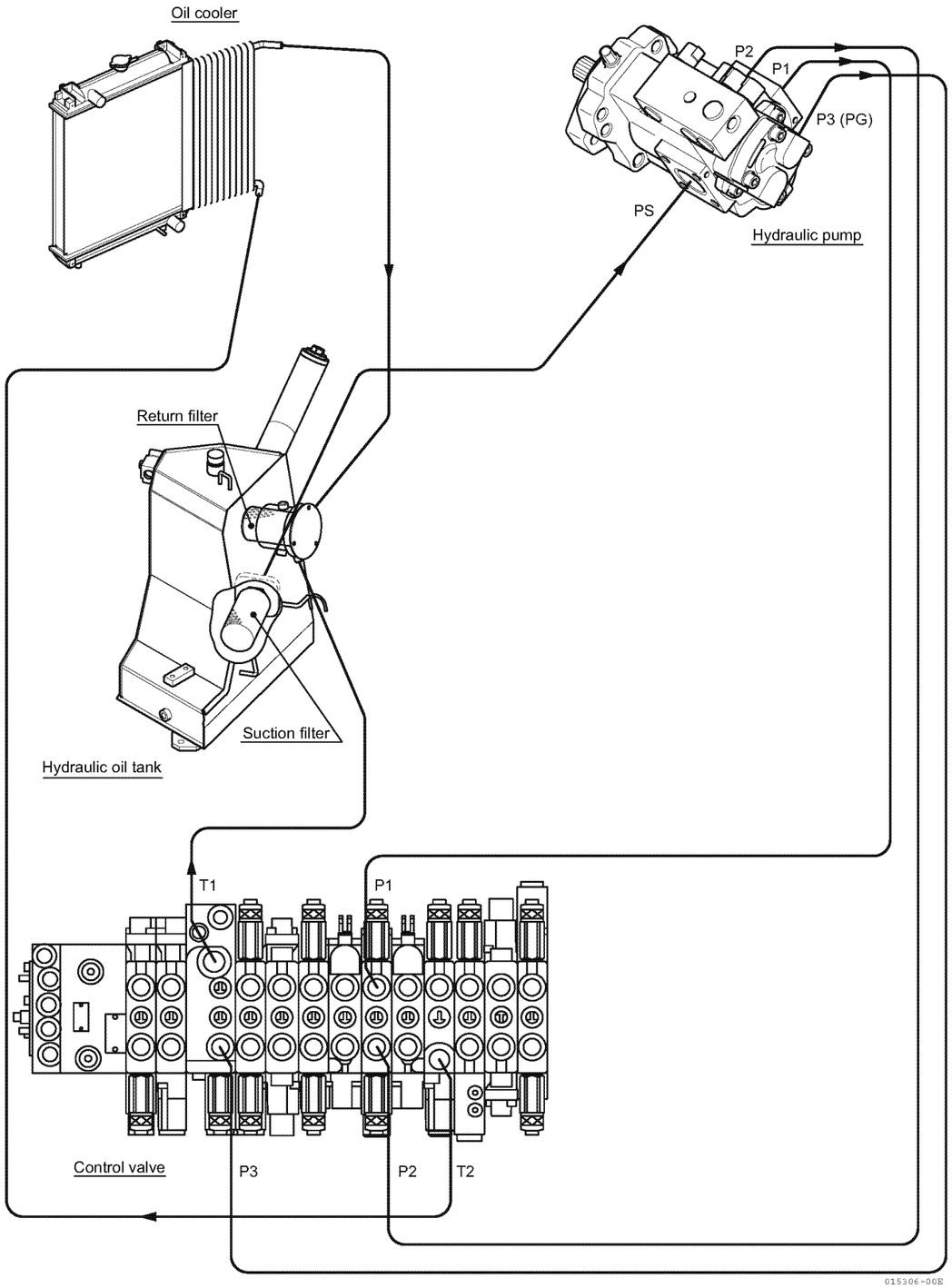
The anti-drift valve is installed in the boom section to reduce the boom drifting.

4) Track Drive Lock

When the lock lever is set to the "LOCK" position, the spool of the inlet section is in the neutral position, so that the oil from the piston pumps P1 and P2 flows back to the hydraulic oil tank through the return passage. Therefore, the implement does not operate and the machine does not travel even when the control or travel lever is operated.



5. HYDRAULIC SYSTEM

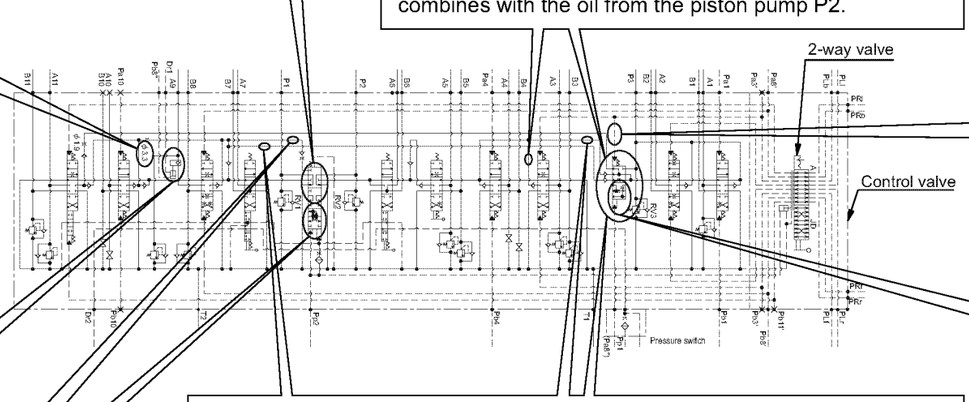


5-1-2 Additional Operation of Control Valve

Safety Lock
(1) With lock lever in "LOCK" position
The spool of the inlet section is in the neutral position, and the oil from the pump port P1 and that from the pump port P2 flow back to the hydraulic oil tank through the return passage. Therefore, no oil is supplied to any sections, and cylinders and motors do not operate even when a spool of every section is moved.
(2) With lock lever in "UNLOCK" position
The oil from the pilot pump P4 flows to the port a2 of the inlet section through the cut-off valve, and the spool of the inlet section is moved.
The oil from the pump P1 and that from the pump P2 can flow to sections to move their spools, and flow to cylinders and motors to operate them.

Simultaneous Operation of Boom and Bucket
The bucket section has a parallel passage so that the boom and bucket can be operated simultaneously and a check valve {ϕ0.13 in. (3.3 mm)} so that the oil can flow to the boom section prior to the bucket section even when the boom is highly loaded.

Combined Oil Flow for Arm Retract Operation
When the arm is retracted, the oil from the port 1 of the pilot valve (LH) flows to the port PLb of the arm section and the parallel-flow divider to move their spools. The oil from the gear pump P3 flows through the parallel-flow divider and the parallel passage to the arm section and combines with the oil from the piston pump P2.



Simultaneous Operation of "Boom Up" and "Arm Retract"
When the arm control lever is pulled back to retract the arm while the boom is raising, the oil from the port 1 of the pilot valve (LH) flows to the port PLb. The pilot oil moves the spool of the parallel-flow divider to the neutral position to let the oil from the gear pump P3 flow into the arm section prior to the boom section.

Anti-Drift Valve (Reduction of Boom Drifting)
The anti-drift valve is installed in the port A9 of the boom section to reduce the boom drifting. The valve blocks the oil in the bottom end circuit of the boom cylinder to prevent the boom from drifting due to internal leakage when the control valve is in the neutral position. When the boom control lever is pushed forward to lower the boom, the oil from the port 3 of the pilot valve (RH) flows to the ports Pb8' and Pb8" to open the check valve, so that the return oil can flow back to the hydraulic oil tank.

Combined Oil Flow for Boom Up Operation
When the boom is operated, the oil from the port 1 of the pilot valve (RH) flows to the port a8 of the boom section and the port a8' of the parallel-flow divider to move their spools. The oil from the gear pump P3 flows through the parallel-flow divider and parallel passage to the boom section and combines with the oil from the piston pump P2.

Non-deviation Travel 2
When the bucket is operated while traveling, the spools of travel and bucket sections are moved to block the pilot oil passage, and then the inlet section spool is moved. The oil discharged from the pump P1 and that from the pump P2 are led to the travel sections and the bucket section, so that the bucket operation while traveling does not cause any deviation.

Non-Deviation Travel 1
When the arm and the boom are simultaneously or individually operated while the machine is traveling, the oil from the pilot valve flows to the port b4' and/or b8' to move the respective spools. The oil from the gear pump P3 is divided at the parallel-flow divider and flows to the arm and/or boom sections through the parallel passage. Consequently, even when the oil from the piston pumps P1 and P2 flows only to the left and right travel sections, respectively, in the most upstream for the pumps P1 and P2, the arm and the boom can be operated. In other words, the machine can travel with no deviation even when the control levers are moved while the machine is traveling.

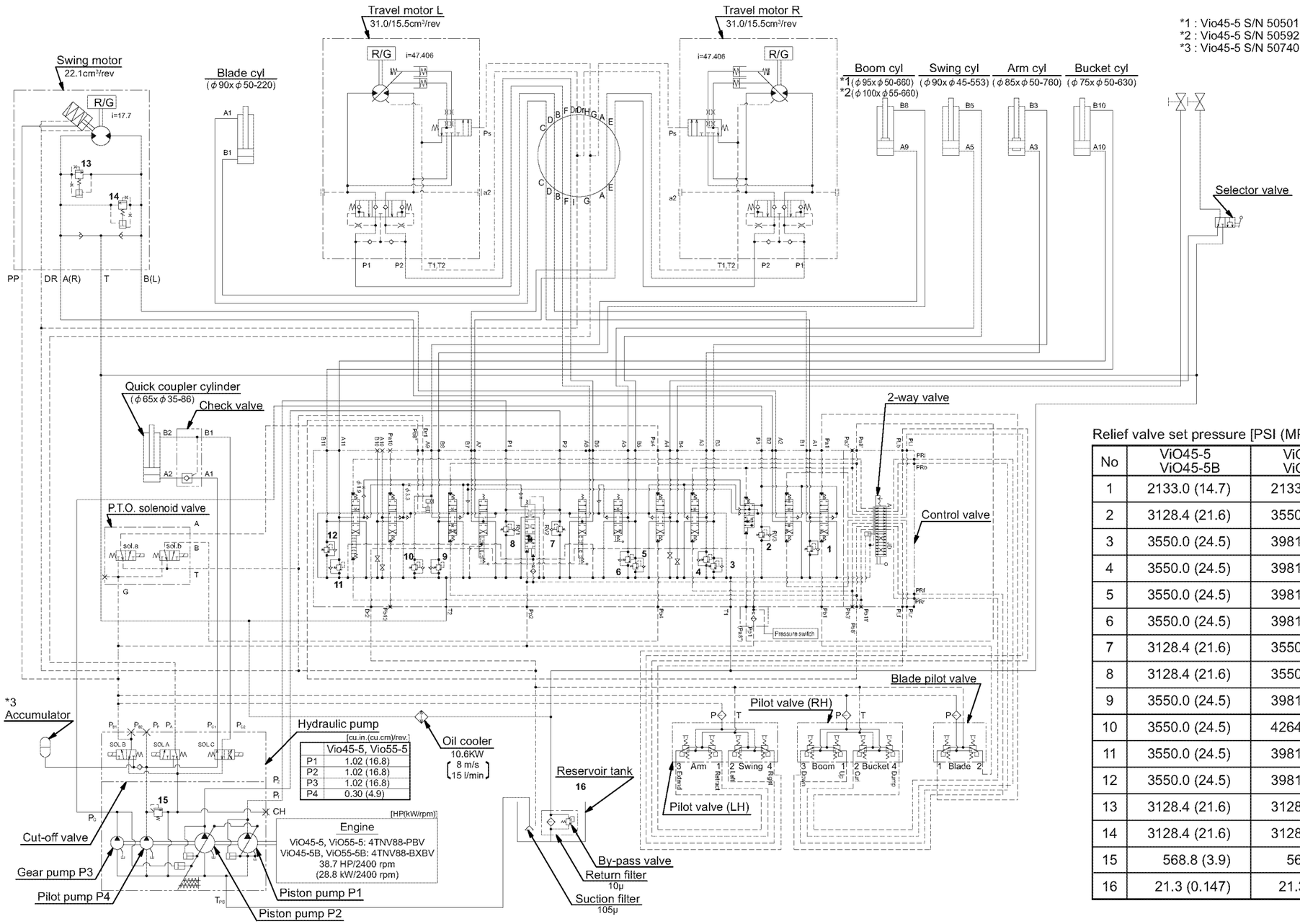
Note : The 2-way valve in the schematic shows the SAE lever pattern position.

015797-00E

5. HYDRAULIC SYSTEM

5-2 Hydraulic Circuit Schematic

Applicable model : ViO45-5, ViO45-5B, ViO55-5, ViO55-5B



Relief valve set pressure [PSI (MPa)]

No	ViO45-5 ViO45-5B	ViO55-5 ViO55-5B
1	2133.0 (14.7)	2133.0 (14.7)
2	3128.4 (21.6)	3550.0 (24.5)
3	3550.0 (24.5)	3981.6 (27.5)
4	3550.0 (24.5)	3981.6 (27.5)
5	3550.0 (24.5)	3981.6 (27.5)
6	3550.0 (24.5)	3981.6 (27.5)
7	3128.4 (21.6)	3550.0 (24.5)
8	3128.4 (21.6)	3550.0 (24.5)
9	3550.0 (24.5)	3981.6 (27.5)
10	3550.0 (24.5)	4264.1 (29.4) *1 *2
11	3550.0 (24.5)	3981.6 (27.5)
12	3550.0 (24.5)	3981.6 (27.5)
13	3128.4 (21.6)	3128.4 (21.6)
14	3128.4 (21.6)	3128.4 (21.6)
15	568.8 (3.9)	568.8 (3.9)
16	21.3 (0.147)	21.3 (0.147)

027541-00E

5-3 Circuit Operation

5-3-1 Boom

1) Boom “Up”

(1) Pilot oil flow

When the boom control lever is pulled back to raise the boom, the oil from the pilot pump P4 flows through the cut-off valve and the port 1 of the pilot valve (RH) to the port Rb of the control valve and the port a8" of the parallel-flow divider through the port a8' and the boom section to move their spools.

(2) Oil flow from hydraulic pump

The oil discharged from the piston pump P1 flows to the boom section through the port P1 of the inlet section, while the oil discharged from the gear pump P3 flows to the boom section through the port P3 of the parallel-flow divider and the parallel passage, and combines with the oil from the piston pump P1. Then the combined oil opens the check valve of the anti-drift valve in the boom section and flows through the port A9 to A9 of the boom cylinder to extend its cylinder rod, raising the boom. The return oil from B8 of the boom cylinder flows back to the hydraulic oil tank through the port B8 of the boom section, the ports T1 and T2 of the control valve and the oil cooler.

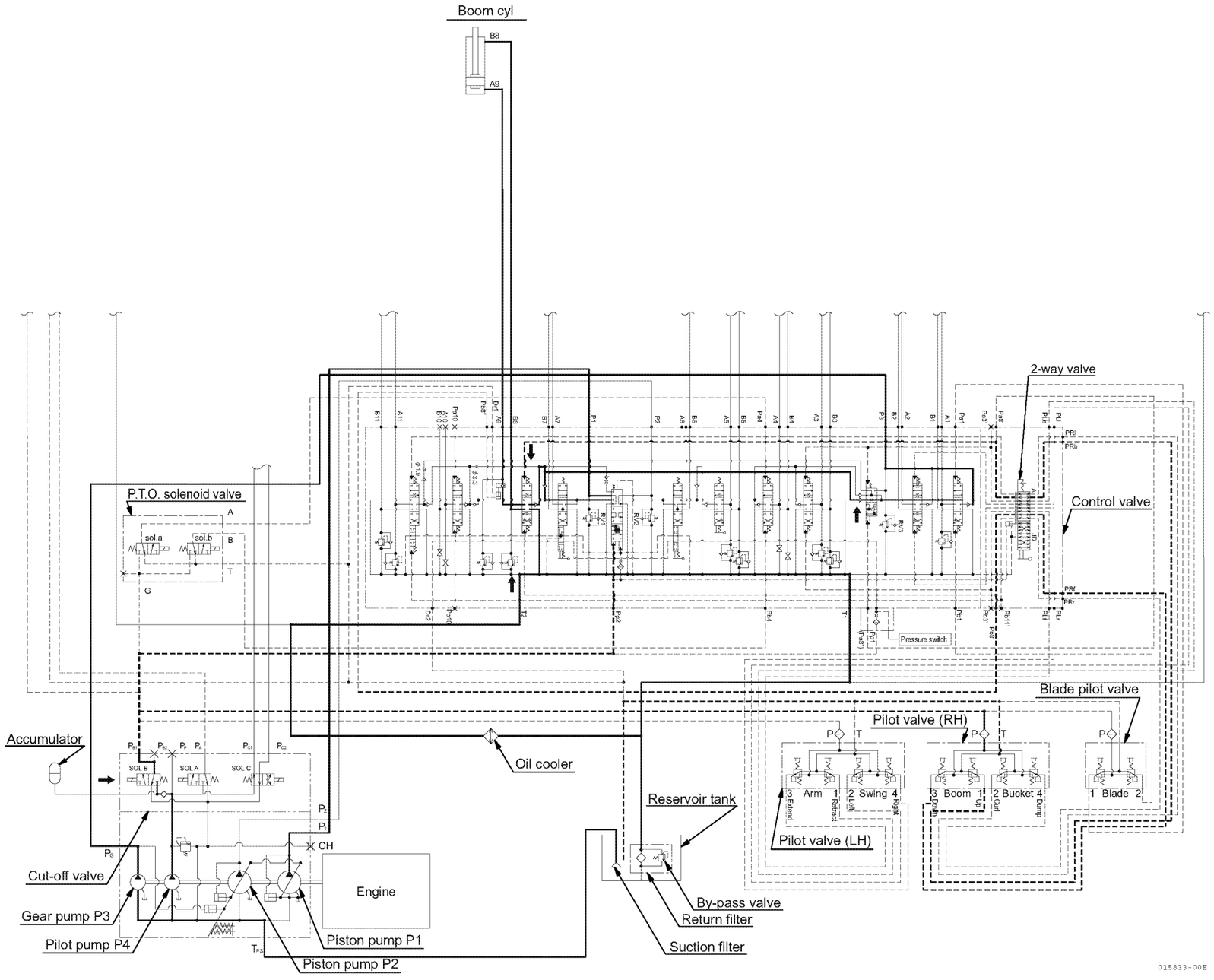
2) Boom "Down"

(1) Pilot oil flow

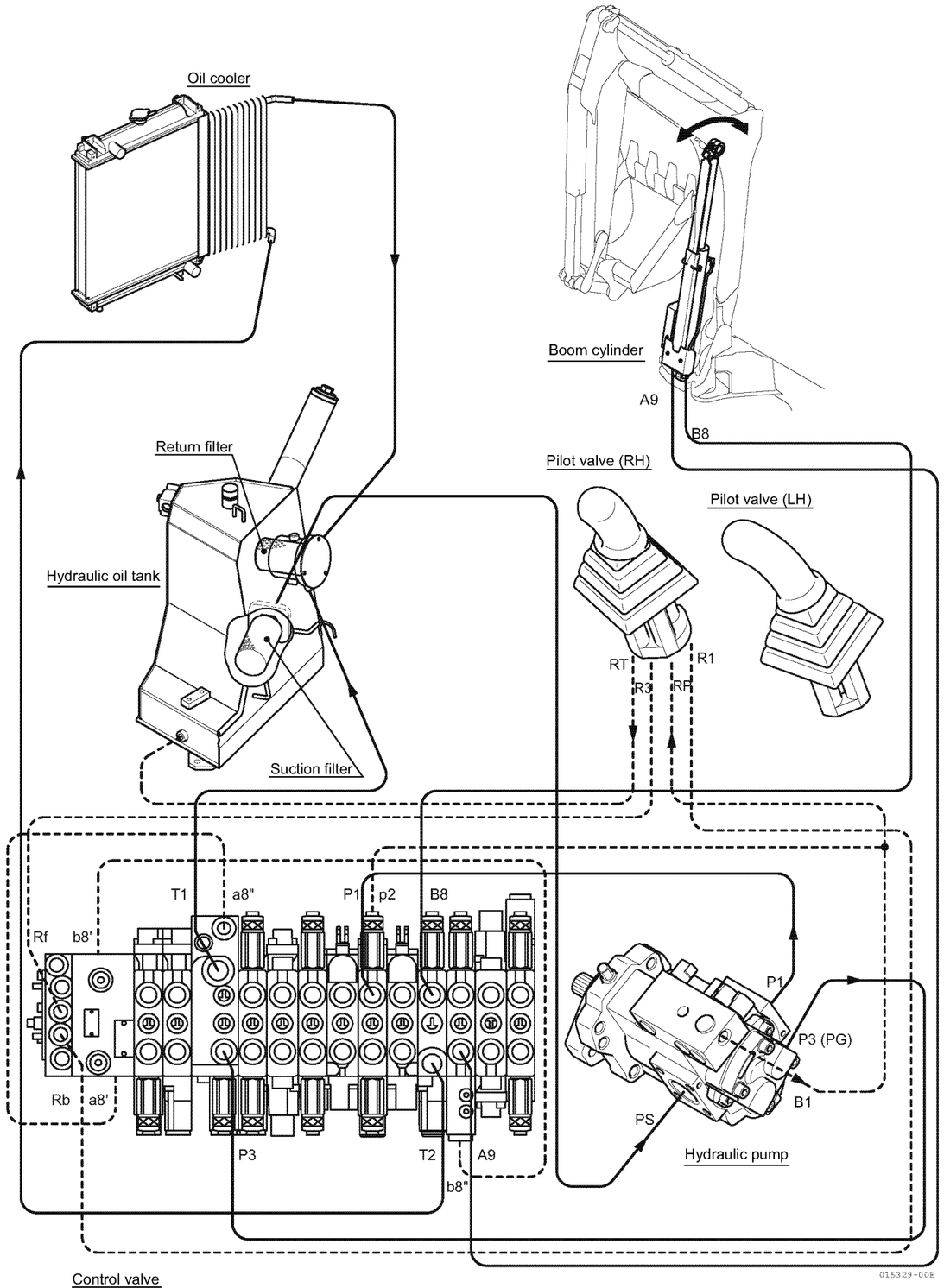
When the boom control lever is pushed forward to lower the boom, the oil from the pilot pump P4 flows to the port b8” of the anti-drift valve through the cut-off valve and the port 3 of the pilot valve (RH) and flows to the port Rf of the control valve to move its spool. The pilot oil also presses the piston of the anti-drift valve to open the check valve.

(2) Oil flow from hydraulic pump

The oil discharged from the piston pump P1 flows through the port P1 of the inlet section to the boom section. In this operation, the oil flows in the opposite direction to the oil flow in the Boom Up operation with regard to the boom cylinder.



5. HYDRAULIC SYSTEM



5-3-2 Arm

1) Arm “Retract”

(1) Pilot oil flow

When the arm control lever is pulled back to retract the arm, the oil from the pilot pump P4 flows through the cut-off valve and the port 1 of the pilot valve (LH) to the port Lb of the control valve, then flows to the parallel-flow divider and the arm sections to move their spools.

(2) Oil flow from hydraulic pump

The oil from the piston pump P2 flows through the port P2 of the inlet section to the arm section. The oil from the gear pump P3 flows through the port P3 of the parallel-flow divider and the parallel passage to the arm section and combines with the oil from the piston pump P2. The combined oil flows through the port A3 of the control valve to A3 of the arm cylinder to extend its cylinder rod. The return oil from B3 of the arm cylinder flows back to the hydraulic oil tank through the port B3 of the arm section, the ports T1 and T2 of the control valve and the oil cooler.

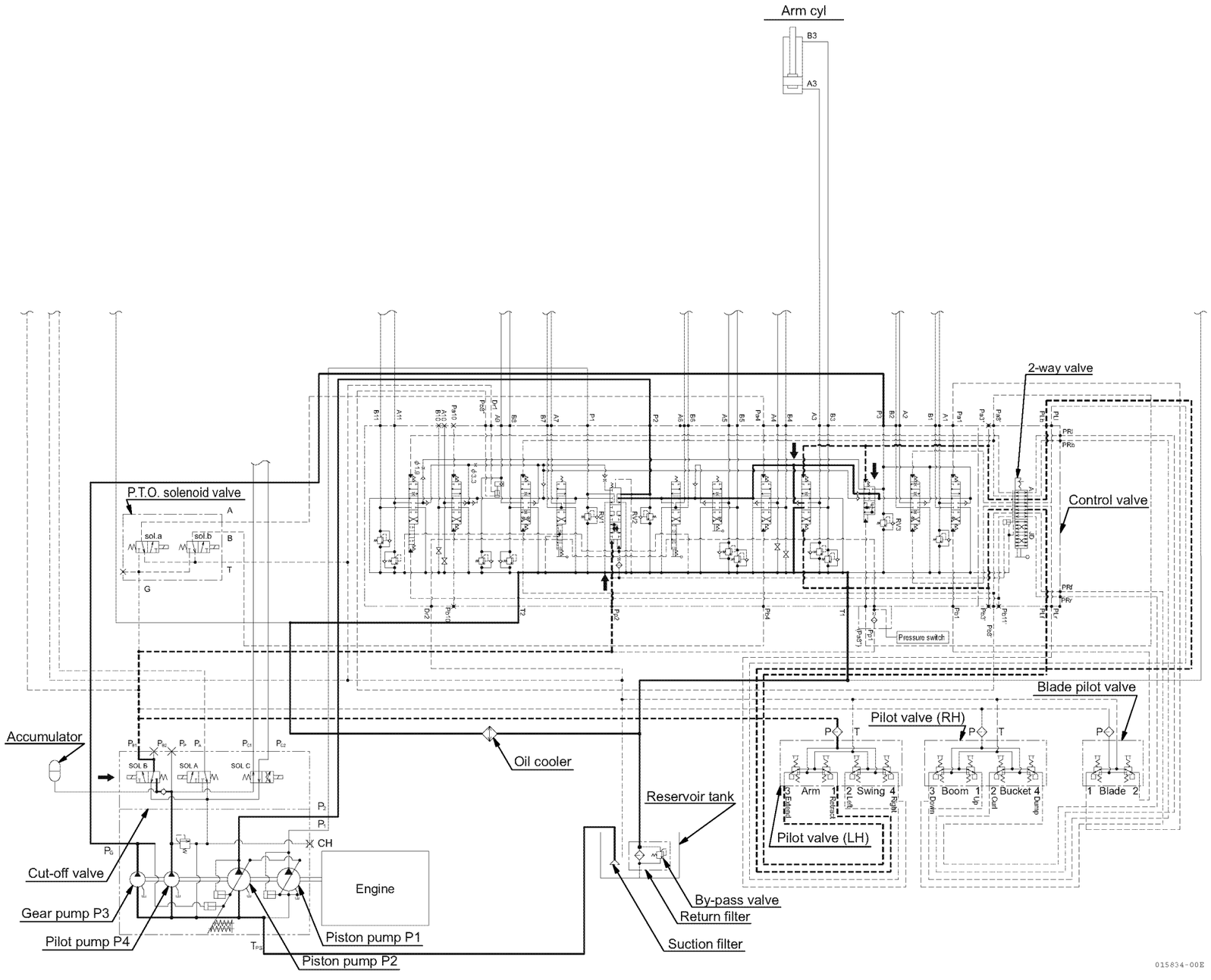
2) Arm "Extend"

(1) Pilot oil flow

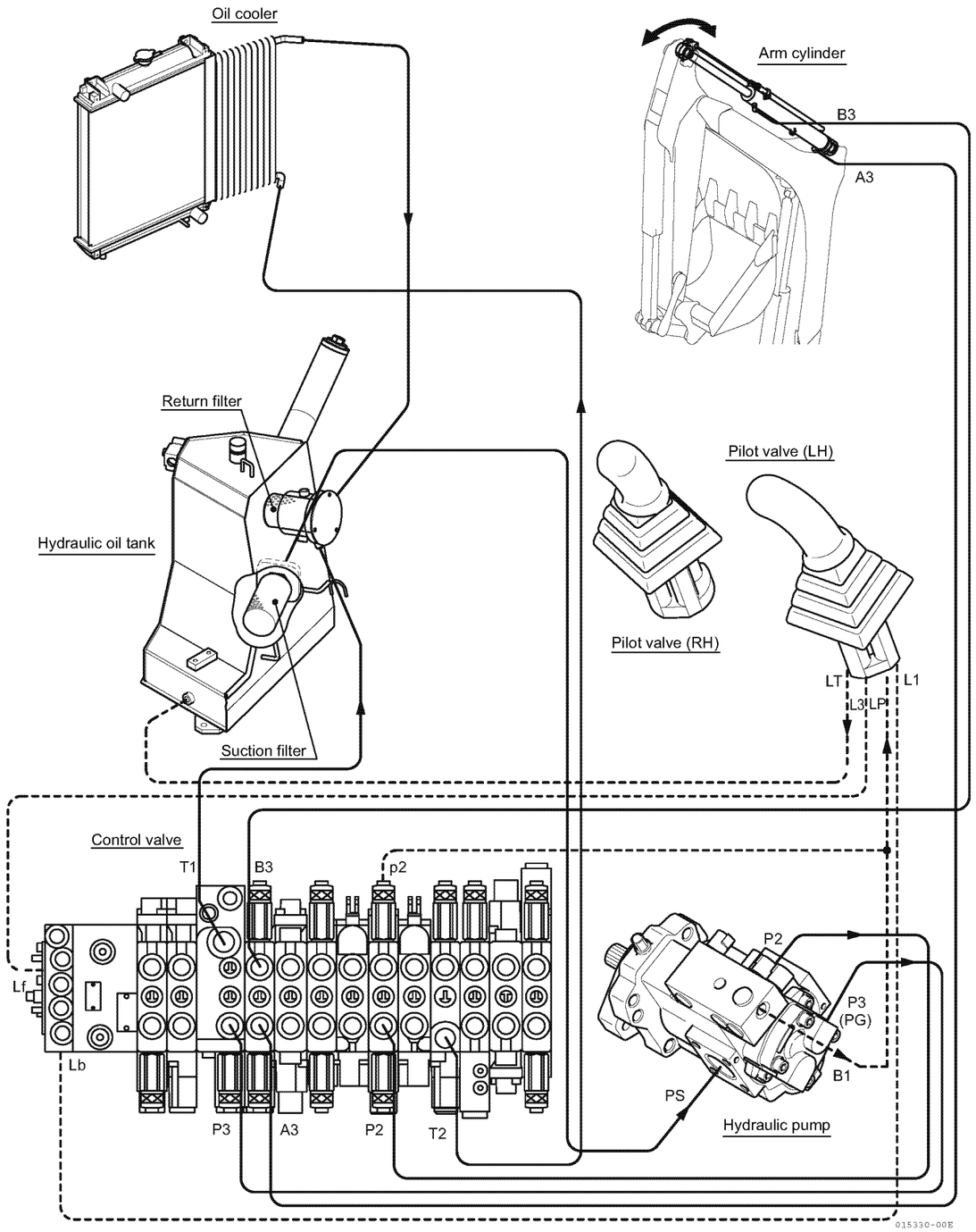
When the arm control lever is pushed forward to extend the arm, the oil from the pilot pump P4 flows through the cut-off valve and the port 3 of the pilot valve (LH) to the arm section through the port Lf of the control valve to move its spool.

(2) Oil flow from hydraulic pump

The oil from the piston pump P2 flows through the port P2 of the inlet section to the arm section. The oil from the gear pump P3 flows through the port P3 of the parallel-flow divider and the parallel passage to the arm section and combines with the oil from the port P2. The combined oil flows in the opposite direction to the oil flow in the arm retract operation with regard to the arm cylinder.



5. HYDRAULIC SYSTEM



5-3-3 Bucket

1) Bucket “Curl”

(1) Pilot oil flow

When the bucket control lever is moved to the left to curl the bucket, the oil from the pilot pump P4 flows through the cut-off valve, the port 2 of the pilot valve (RH) and the port RI of the control valve to the bucket section to move its spool.

(2) Oil flow from hydraulic pump

The oil from the piston pump P1 flows through the port P1 of the inlet section to the bucket section, the port A10 of the control valve and to the A10 of the bucket cylinder to extend its cylinder rod.

The return oil from B10 of the bucket cylinder flows back to the hydraulic oil tank through the port B10 of the bucket section, the ports T1 and T2 of the control valve and the oil cooler.

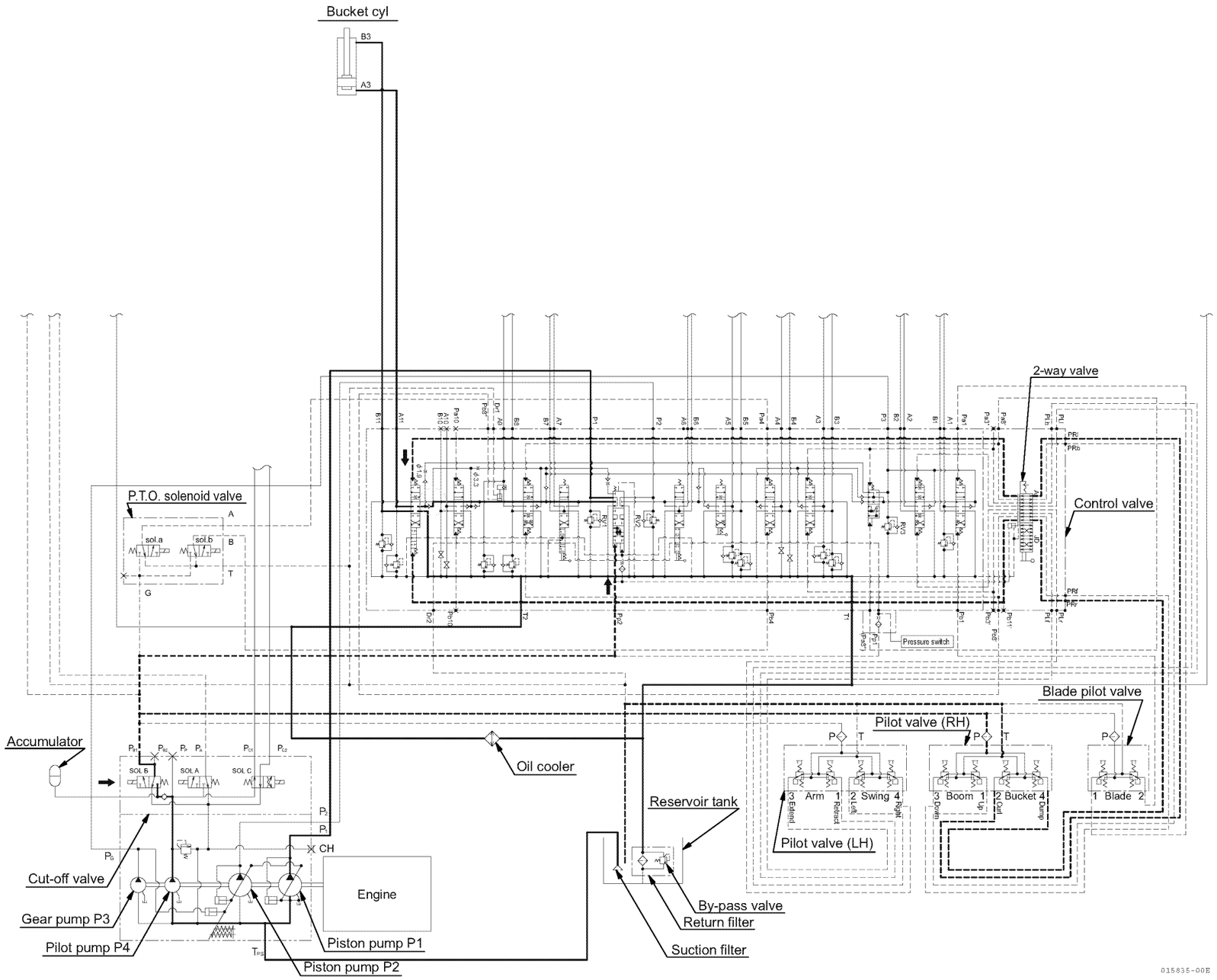
2) Bucket "Dump"

(1) Pilot oil flow

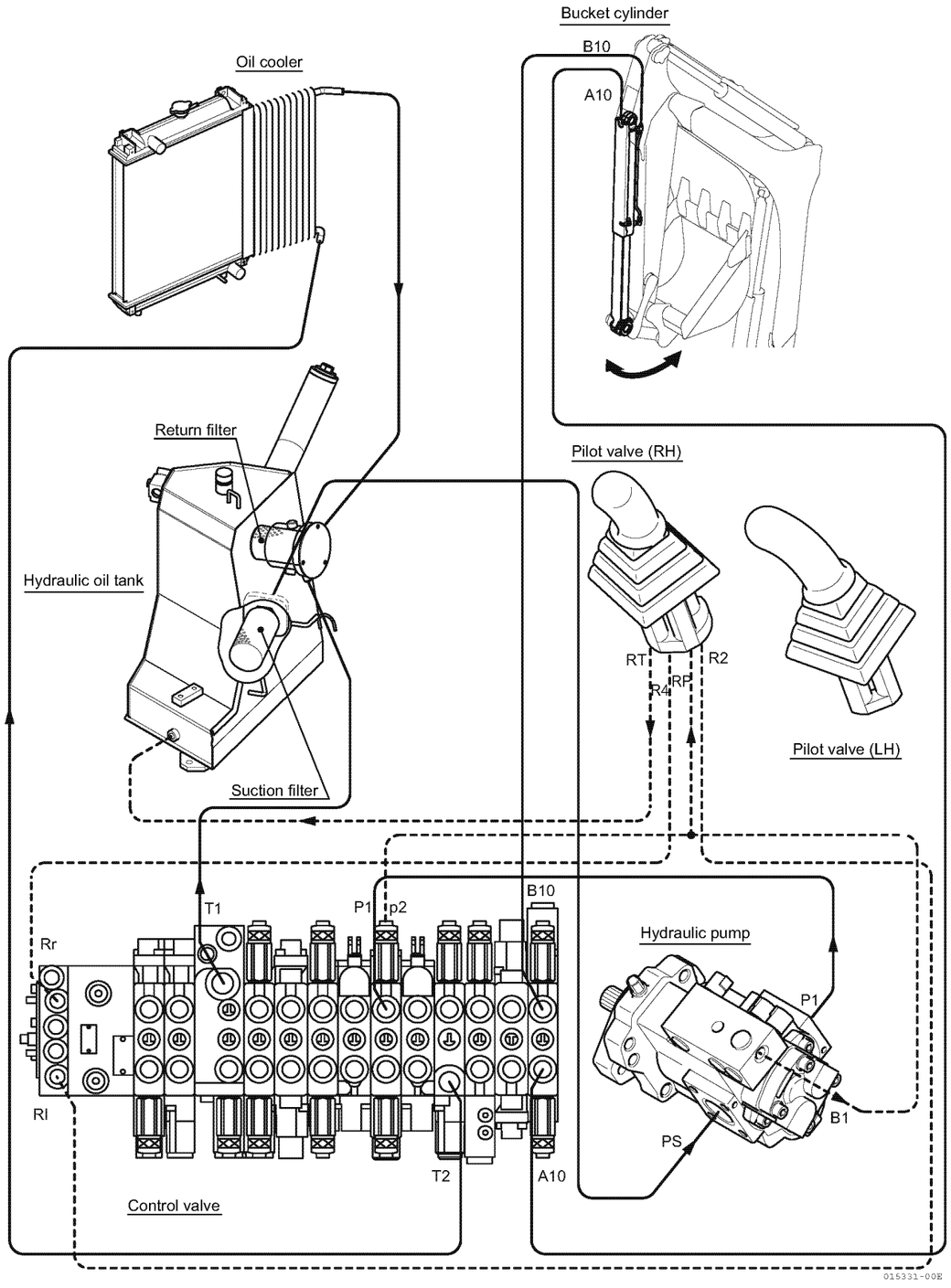
When the bucket control lever is moved to the right to dump the bucket, the oil from the pilot pump P4 flows through the cut-off valve, the port 4 of the pilot valve (RH) and the port Rr of the control valve to the bucket section to move its spool.

(2) Oil flow from hydraulic pump

The oil flows in the opposite direction to the oil flow in the Bucket Curl operation with regard to the bucket cylinder.



5. HYDRAULIC SYSTEM



5-3-4 Swing

1) Right Swing
(1) Pilot oil flow
When the swing control lever is moved to the right, the oil from the pilot pump P4 flows through the cut-off valve, the port 4 of the pilot valve (LH) and the port Lr of the control valve to the swing section to move its spool.

(2) Oil flow from hydraulic pump
The oil from the gear pump P3 flows through the port P3 of the parallel-flow divider and the port B2 of the swing section to the port A1 of the brake valve, so that the swing motor is rotated.
The return oil from the port B1 of the brake valve flows back to the hydraulic oil tank through the port A2 of the swing section, the ports T1 and T2 of the control valve and the oil cooler.

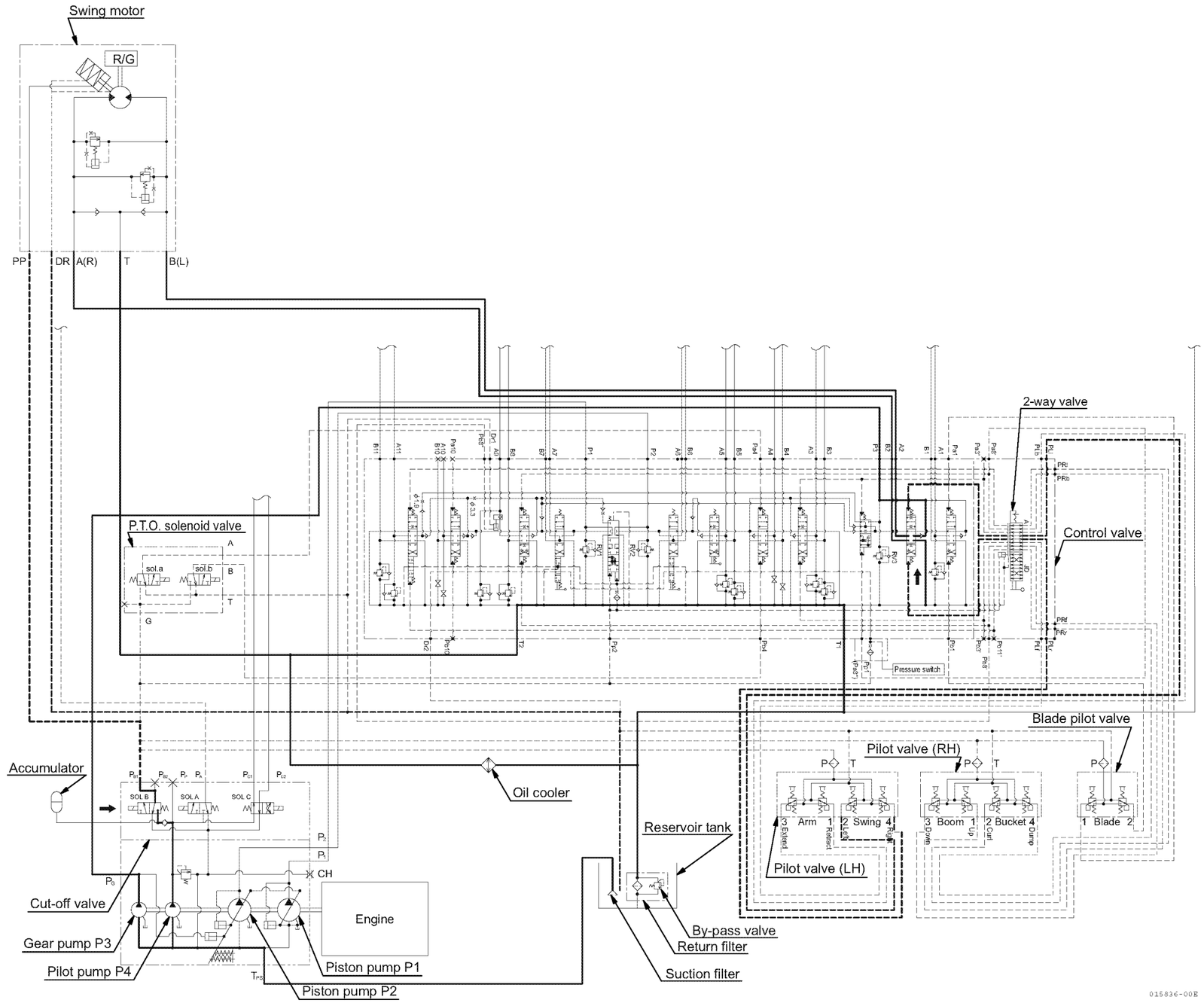
2) Left Swing
(1) Pilot oil flow
When the swing control lever is moved to the left, the oil from the pilot pump P4 flows through the cut-off valve, the port 2 of the pilot valve (LH) and the port Ll of the control valve to the swing section to move its spool.

(2) Oil flow from hydraulic pump
The oil flows in the opposite direction to the oil flow in the Right Swing operation with regard to the swing motor.

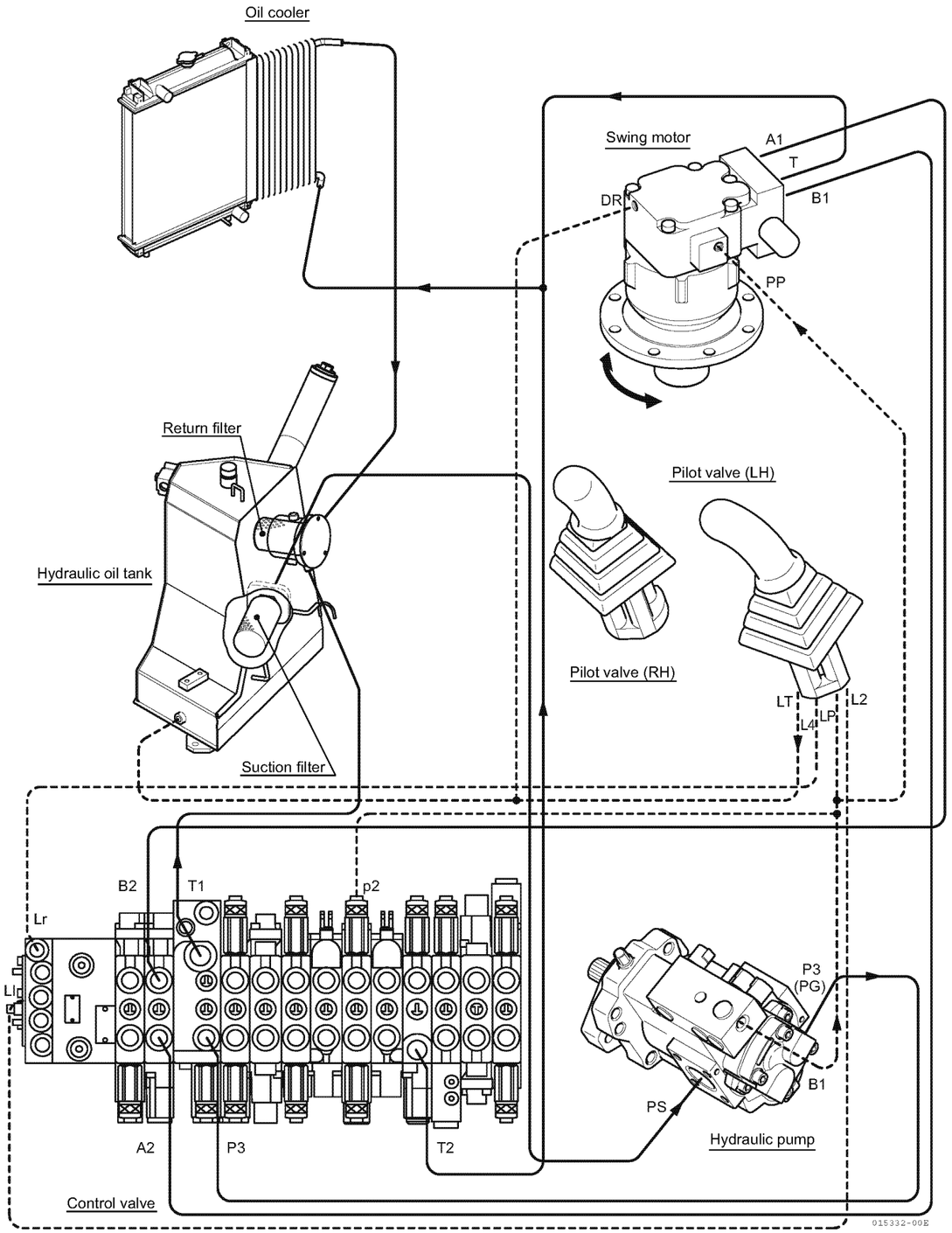
3) Release and Operation of Swing Motor Mechanical Brake
(1) Release
When the lock lever is pushed forward, the oil from the pilot pump P4 flows to the port PP of the swing motor and presses the piston (with a spring) of the swing motor mechanical brake to release the brake.

(2) Operation
When the lock lever is pulled backward, the oil from the pilot pump P4 does not flow to the swing motor so that the spring force causes the brake to be applied.

4) Swing Motor Hydraulic Brake Operation
When the swing control lever is released (i.e., returned to the neutral position), the oil flow to the swing motor is blocked and the pressures at the ports A1 and B1 of the brake valve become equal and consequently the brake is applied. However, the swing motor continues to rotate in a short time due to its inertia. This causes the motor to act like a pump and increases the circuit pressure on the port B2 side. The increased pressure opens the relief valve SR1 to let the oil on the lower pressure side escape to the port A2, so that the circuit pressure is absorbed and cavitation is prevented on the port A2 side.
The port T of the swing motor has the drain function and a circuit which directly takes in the return oil flowing from the port T2 to the hydraulic oil tank to prevent negative pressure in the swing motor.
The relief valve of the hydraulic brake is a shockless type which has a piston to absorb the shock caused by the brake operation.



5. HYDRAULIC SYSTEM



5-3-5 Boom Swing

The boom swing pedal is linked to the spool of the control valve through an L-ball and a rod.

1) Right Boom Swing

Oil Flow from Hydraulic Pump

When the boom swing pedal is moved on the right, the spool is pressed forward. The oil from the piston pump P2 flows through the port P2 of the inlet section and the port B5 of the boom swing section to B5 of the boom swing cylinder to retract its cylinder rod.

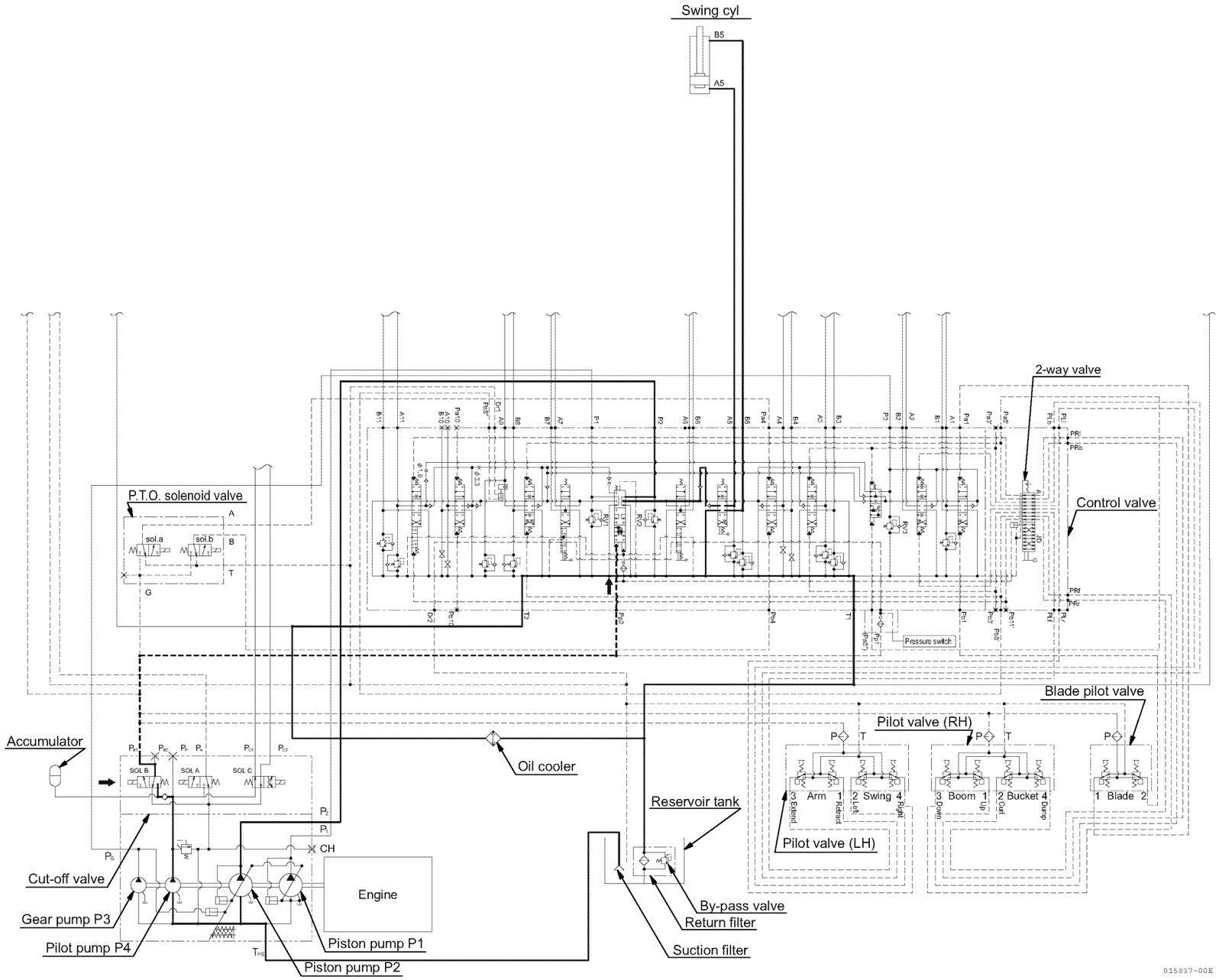
The return oil from A5 of the boom swing cylinder flows back to the hydraulic oil tank through the port A5 of the boom swing section, the ports T1 and T2 of the control valve and the oil cooler.

2) Left Boom Swing

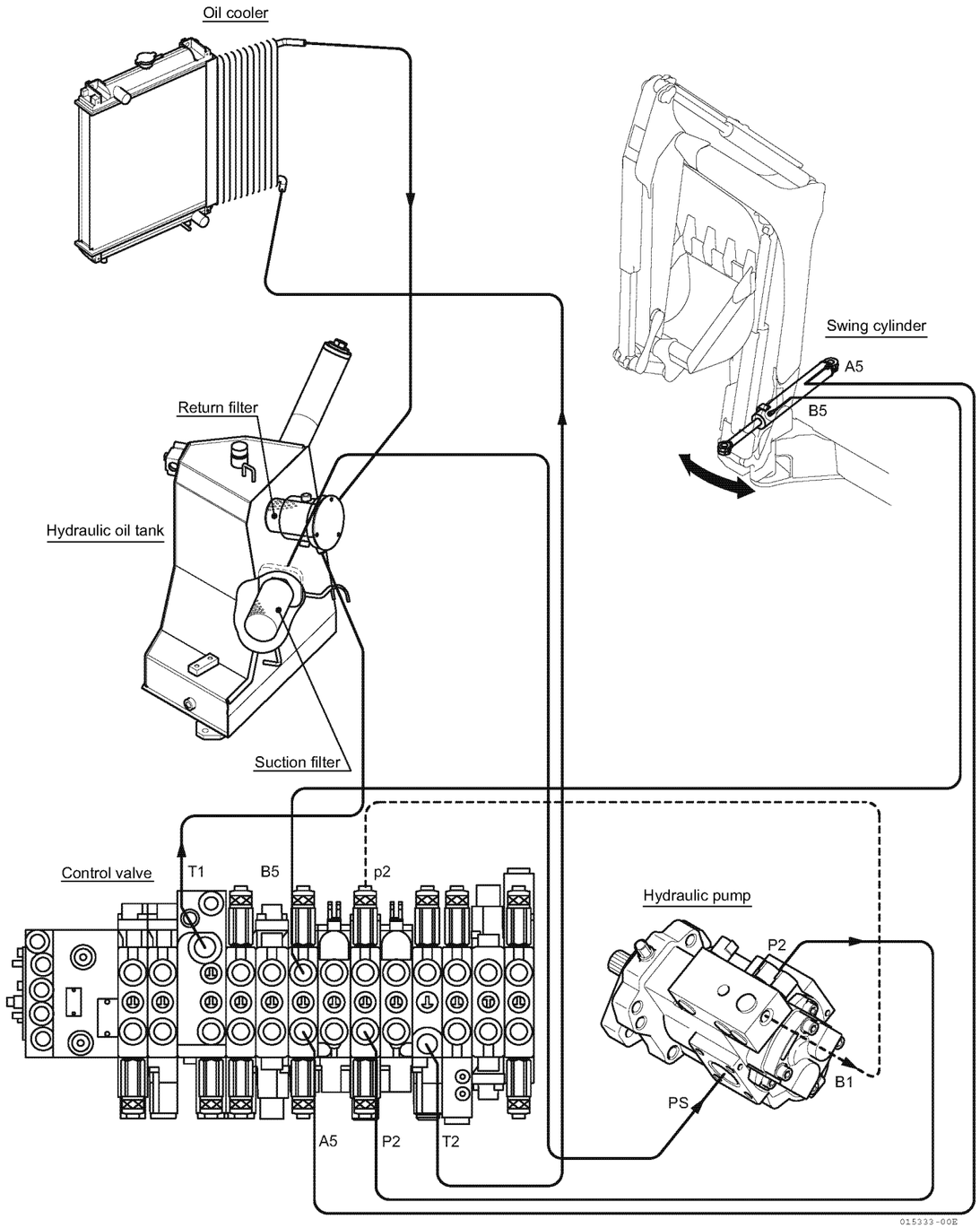
Oil Flow from Hydraulic Pump

When the boom swing pedal is moved on the left, the spool is pulled back.

The oil flows in the opposite direction to the oil flow in the right boom swing operation with regard to the boom swing cylinder.



5. HYDRAULIC SYSTEM



5-3-6 Blade

1) Blade "Down"

(1) Pilot oil flow

When the blade lever is pushed forward, the oil from the pilot pump P4 flows through the cut-off valve and the port 2 of the blade control pilot valve to the port b1 of the blade section to move its spool.

(2) Oil Flow from Hydraulic Pump

When the blade lever is pushed forward to lower the blade, the oil from the gear pump P3 flows through the port P3 of the P3 inlet section the blade section, the port B1 of the control valve and the port D of the swivel joint to B1 of the blade cylinder to extend its cylinder rod, lowering the blade.

The return oil from A1 of the blade cylinder flows back to the hydraulic oil tank through the port C of the swivel joint, the port A1 of the blade section, the ports T1 and T2 of the control valve and the oil cooler.

2) Blade "UP"

(1) Pilot oil flow

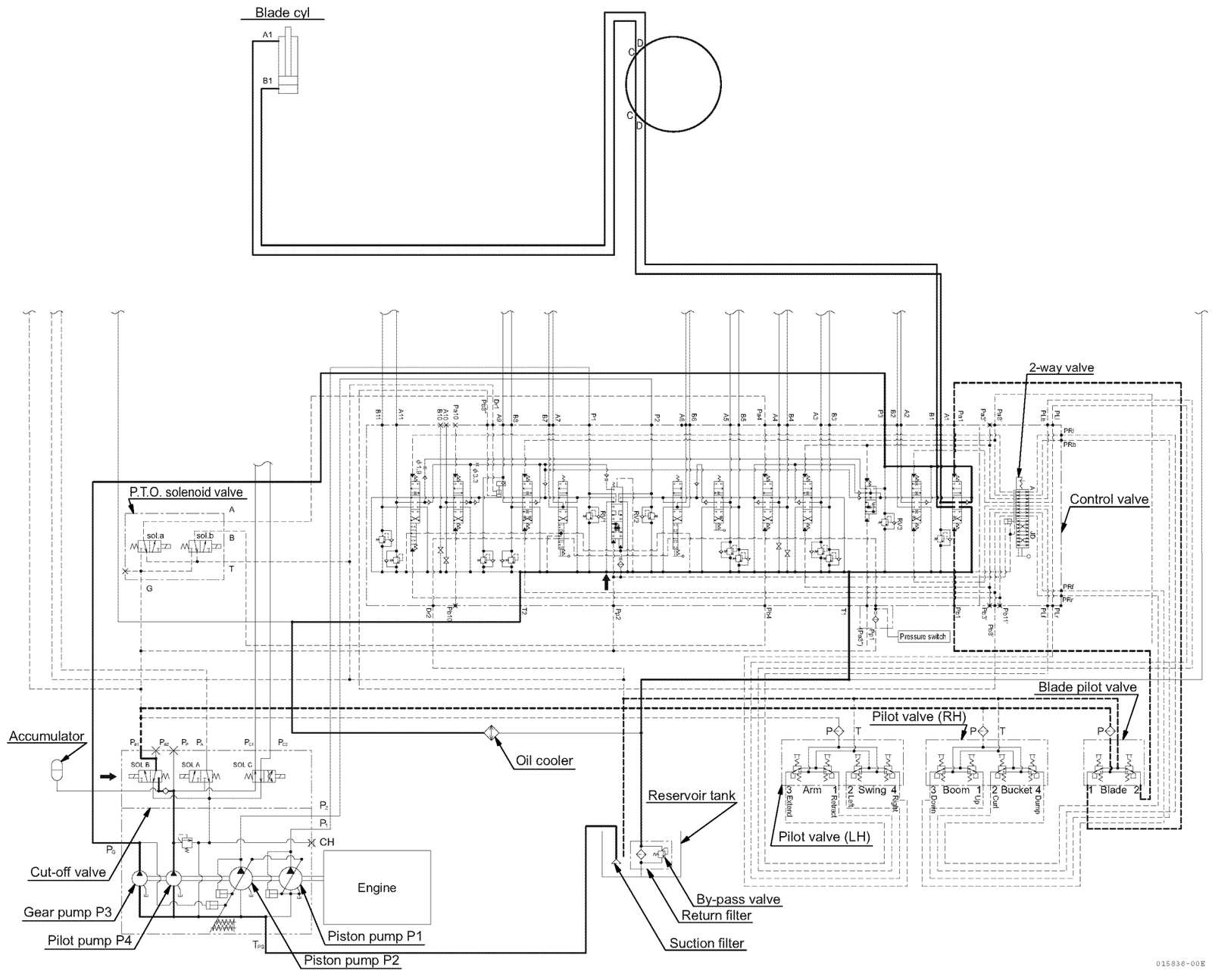
When the blade lever is pulled backward, the oil from the pilot pump P4 flows through the cut-off valve and the port 1 of the blade control pilot valve to the port a1 of the blade section to move its spool.

(2) Oil Flow from Hydraulic Pump

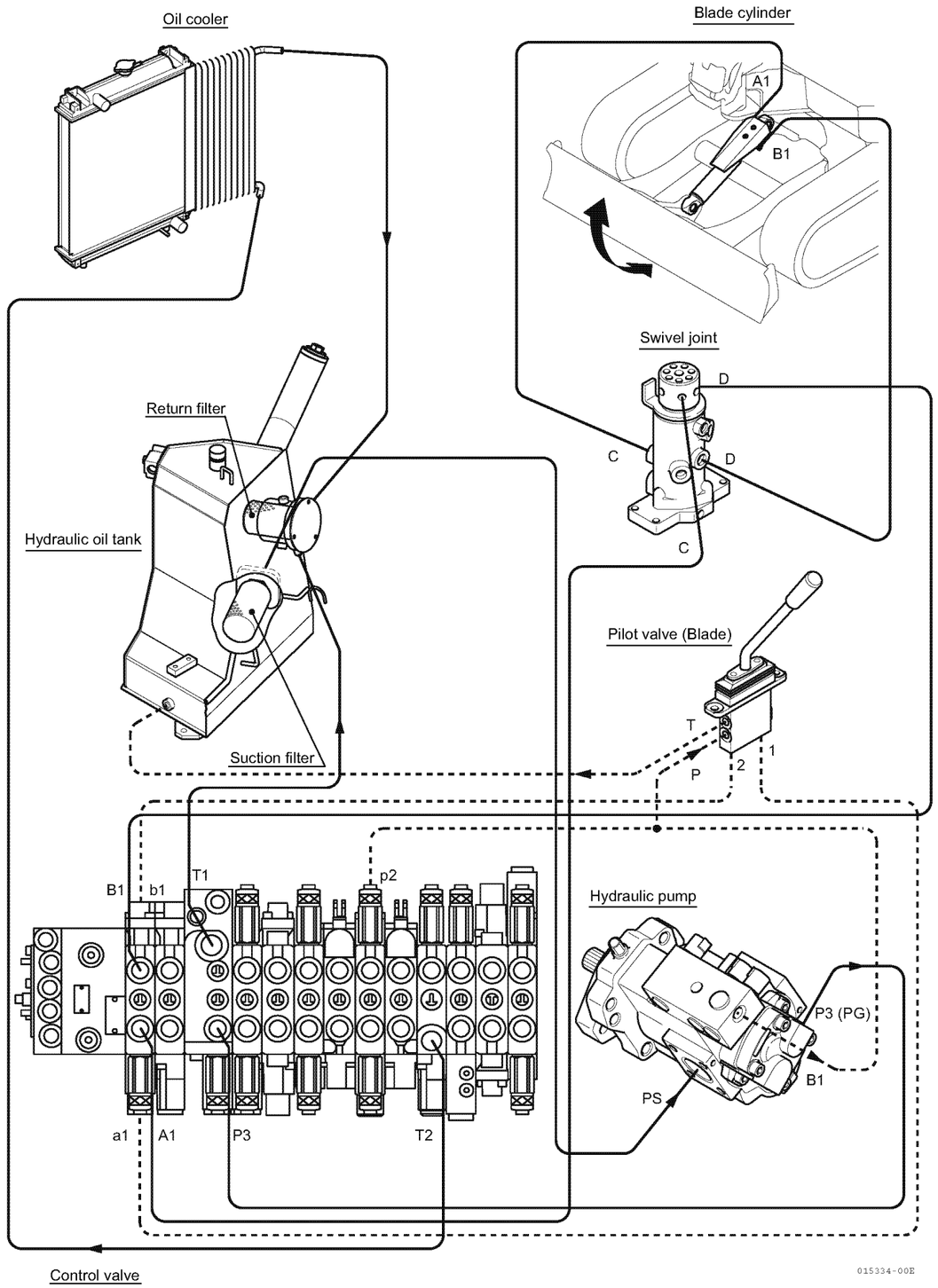
The oil flows in the opposite direction to the oil flow in the blade down operation with regard to the blade cylinder.

3) Circuit Relief Valve Installed in Blade "Up" Circuit

When the blade is raised while the machine is traveling, the oil quantity control function of the hydraulic pump operates to reduce its discharge volume, and the travel speed is slowed down. To minimize such speed reduction, a circuit relief valve with the set pressure lower than that of the system relief valve is installed in the blade cylinder circuit for raising the blade.



5. HYDRAULIC SYSTEM



5-3-7 Travel

Each travel lever is linked to the spool of the control valve through an L-ball and a rod.

1) Forward Travel (Right)
Oil Flow from Hydraulic Pump
When the right travel lever is pushed forward, the spool of the right travel section is pulled up.
The oil from the piston pump P1 flows through the port P1 of the inlet section, the port A7 of the right travel section and the port E of the swivel joint to the port P2 of the right travel motor to rotate it.
The return oil from the port P1 of the right travel motor flows back to the hydraulic oil tank through the port A of the swivel joint, the port B7 of the right travel section, the ports T1 and T2 of the control valve and the oil cooler.

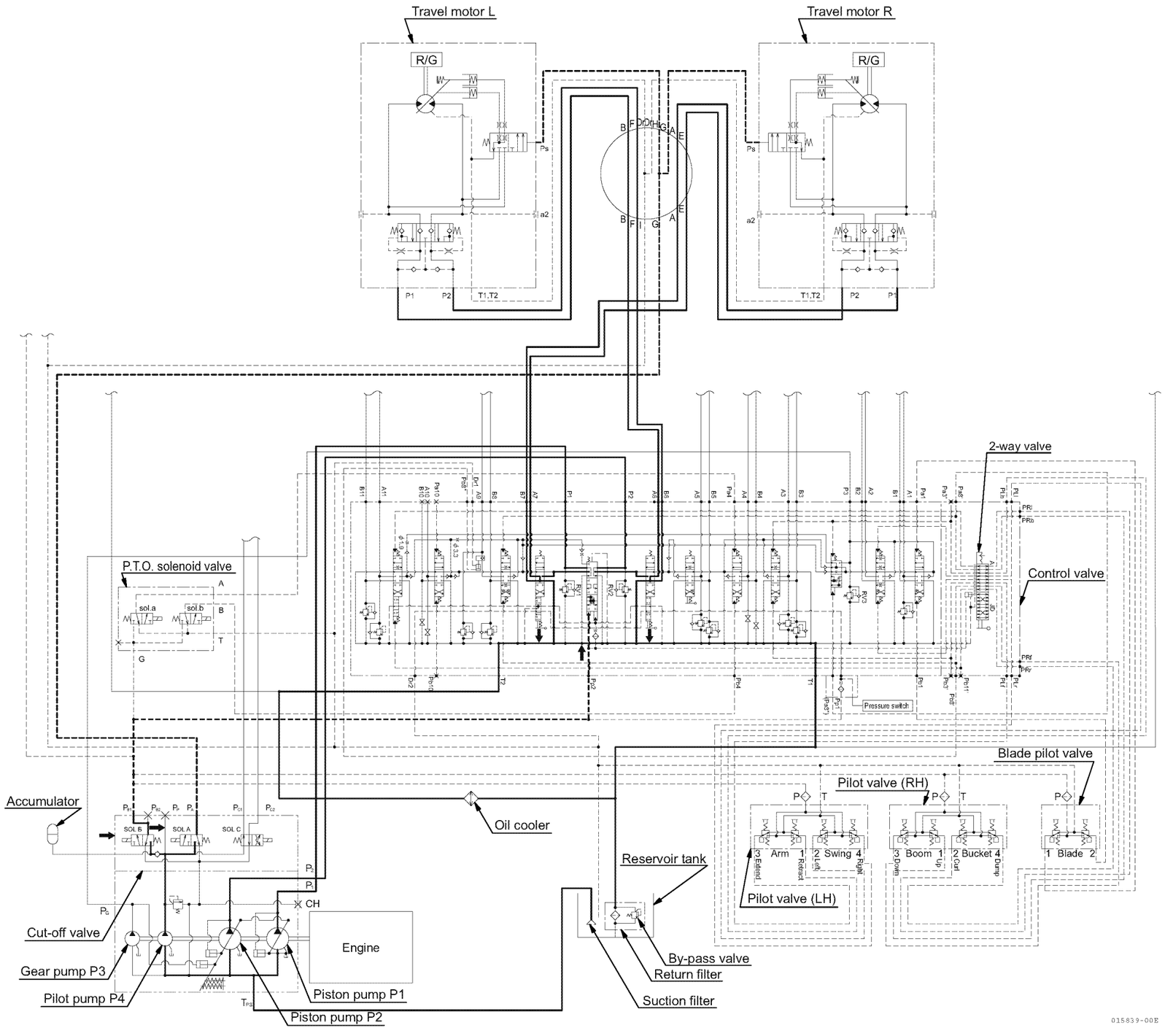
2) Forward Travel (Left)
Oil Flow from Hydraulic Pump
The oil from the piston pump P2 flows through the port P2 of the inlet section, the port A6 of the left travel section and the port B of the swivel joint to the port P1 of the left travel motor to rotate it.
The return oil from the port P2 of the left travel motor flows back to the hydraulic oil tank through the port F of the swivel joint, the port B6 of the left travel section, the ports T1 and T2 of the control valve and the oil cooler.

3) Reverse Travel (Right and Left)
Oil Flow from Hydraulic Pump
When the right or left travel lever is pulled back, the spool of the travel section is pressed down.
The oil flows in the opposite direction to the oil flow in the Forward Travel operation with regard to the right or left travel motor.

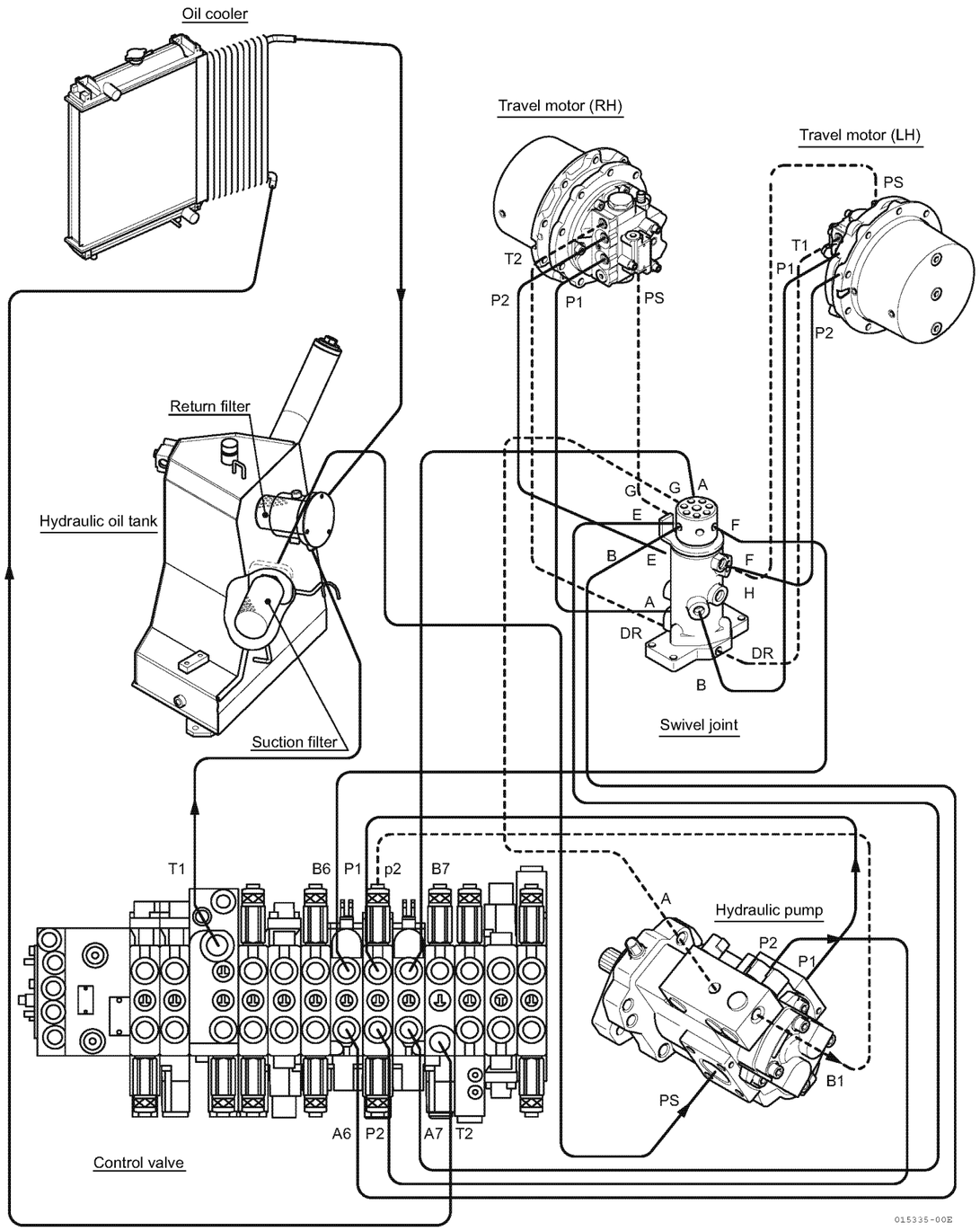
4) High-Speed Function
When the high-speed pedal is moved, the signal is transmitted from the safety switch to the solenoid valve A to increase the travel speed.

(1) Pilot oil flow
When the high-speed pedal is moved, the signal is transmitted from the safety switch to the cut-off valve and the solenoid valve A is opened. The oil from the pilot pump P4 flows through the port A of the solenoid valve A to the port G of the swivel joint and is divided into two flows to the ports G and H there to flow to the port Ps of each travel motor.

(2) Increase in output speed of travel motor
The pilot oil from the pilot pump P4 moves the swash plate control piston to reduce the inclination angle of the swash plate, which shortens the piston stroke of the travel motor and decreases the travel motor capacity to increase its output speed. This increases the travel speed.
Meanwhile, the travel driving force weakens as the output torque of the travel motor becomes smaller due to the shortened piston stroke.



5. HYDRAULIC SYSTEM



5-3-8 Non-Deviation Travel (with Boom, Arm or Boom Swing Operation)

Oil Flow from Hydraulic Pump

1) Travel Section

The oil from the piston pump P1 and that from the piston pump P2 flow through the ports P1 and P2 of the inlet section to the right and left travel sections, respectively. The right and left travel sections are each connected in series in their respective section groups and located the most upstream in the circuits of the piston pumps P1 and P2, respectively. Therefore, all of the oil from each piston pump flows to the travel motor when the travel lever is operated.

2) Boom Section

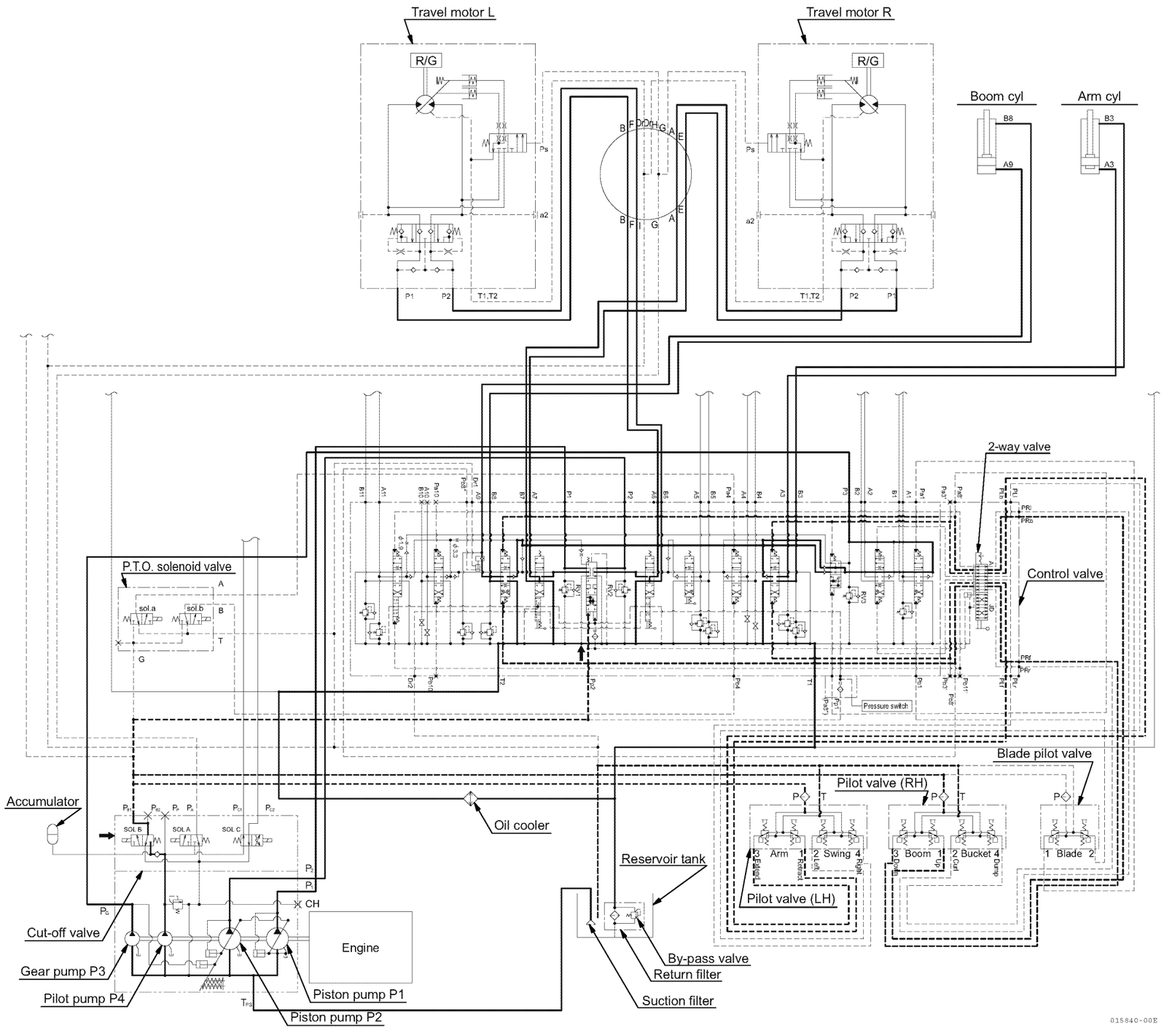
The oil from the gear pump P3 flows through the parallel-flow divider and the parallel passage to the boom section. Therefore, the machine can travel with no deviation even when the boom control lever is moved while the machine is traveling.

3) Arm Section

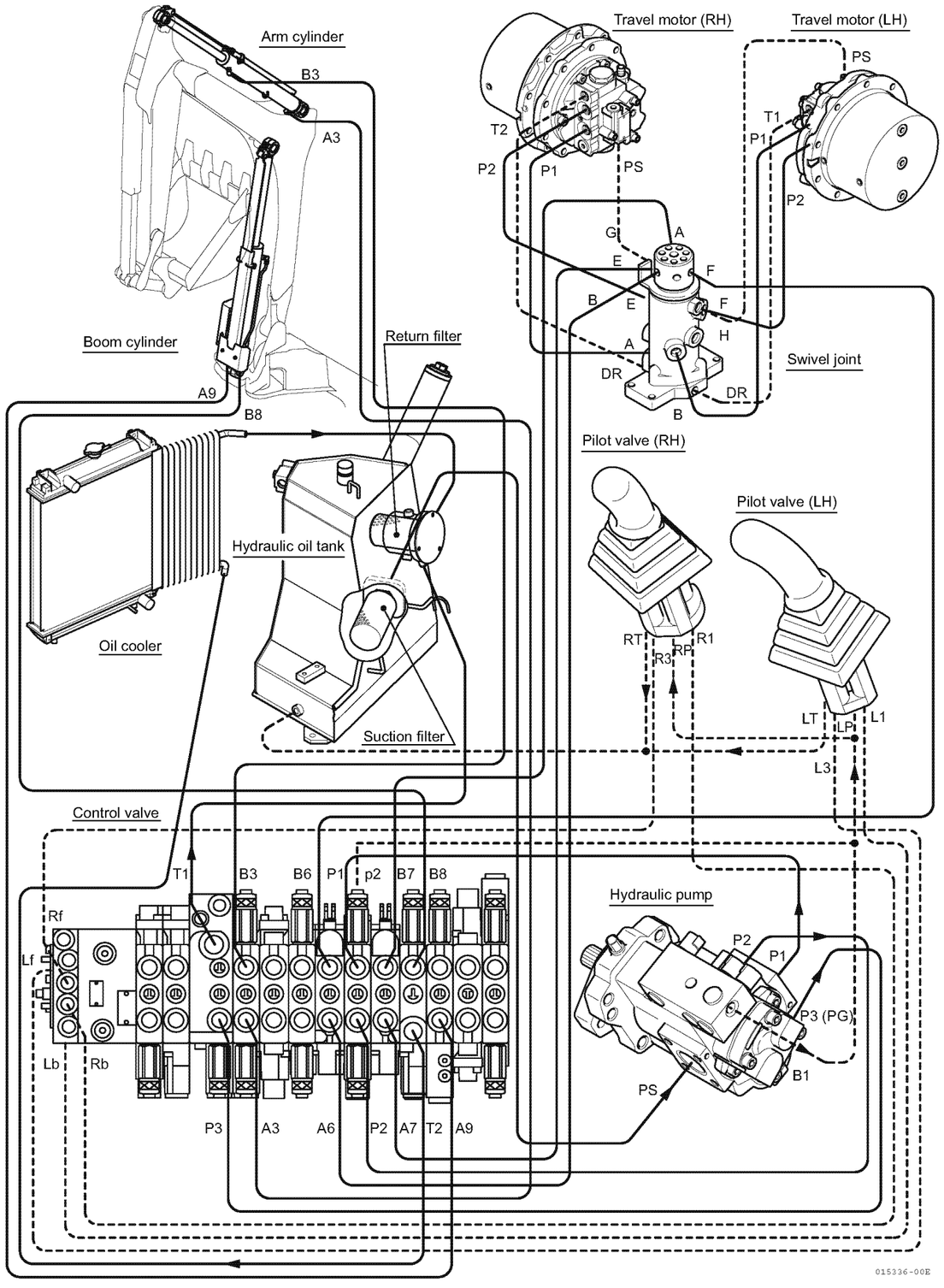
The oil from the gear pump P3 flows through the parallel-flow divider, blade and swing sections and the parallel passage to the arm section. Therefore, the machine can travel with no deviation even when the arm control lever is moved while the machine is traveling.

4) Boom Swing Section

All the oil in the circuit of the piston pump P2 is supplied to the travel section in the most upstream for the pump P2, and the boom swing section in the downstream is supplied with no oil. None of the oil from the gear pump P3 is supplied to the boom swing section, either, so that the boom does not swing while the machine is traveling.



5. HYDRAULIC SYSTEM

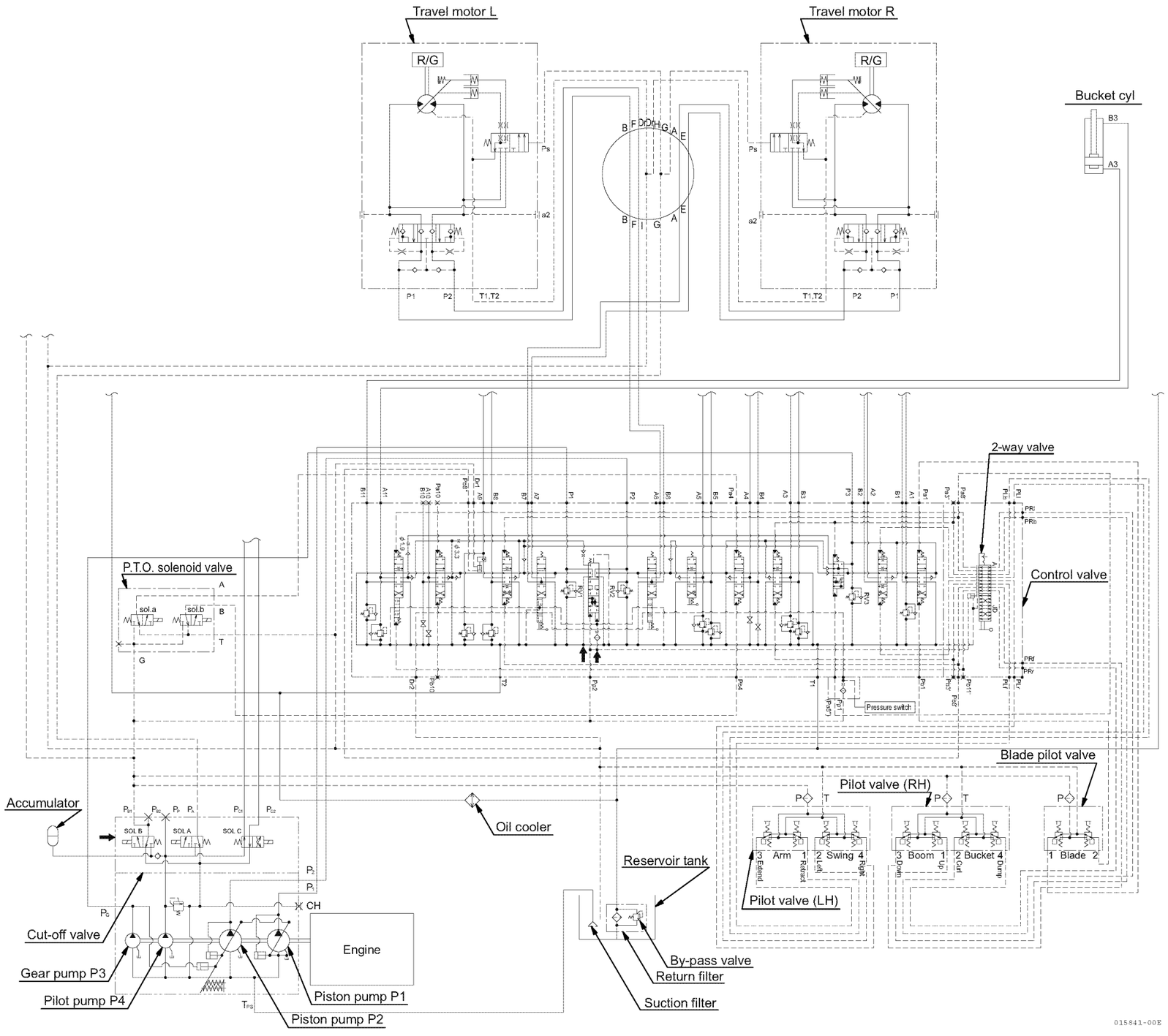


5-3-9 Non-Deviation Travel (with Bucket Operation)

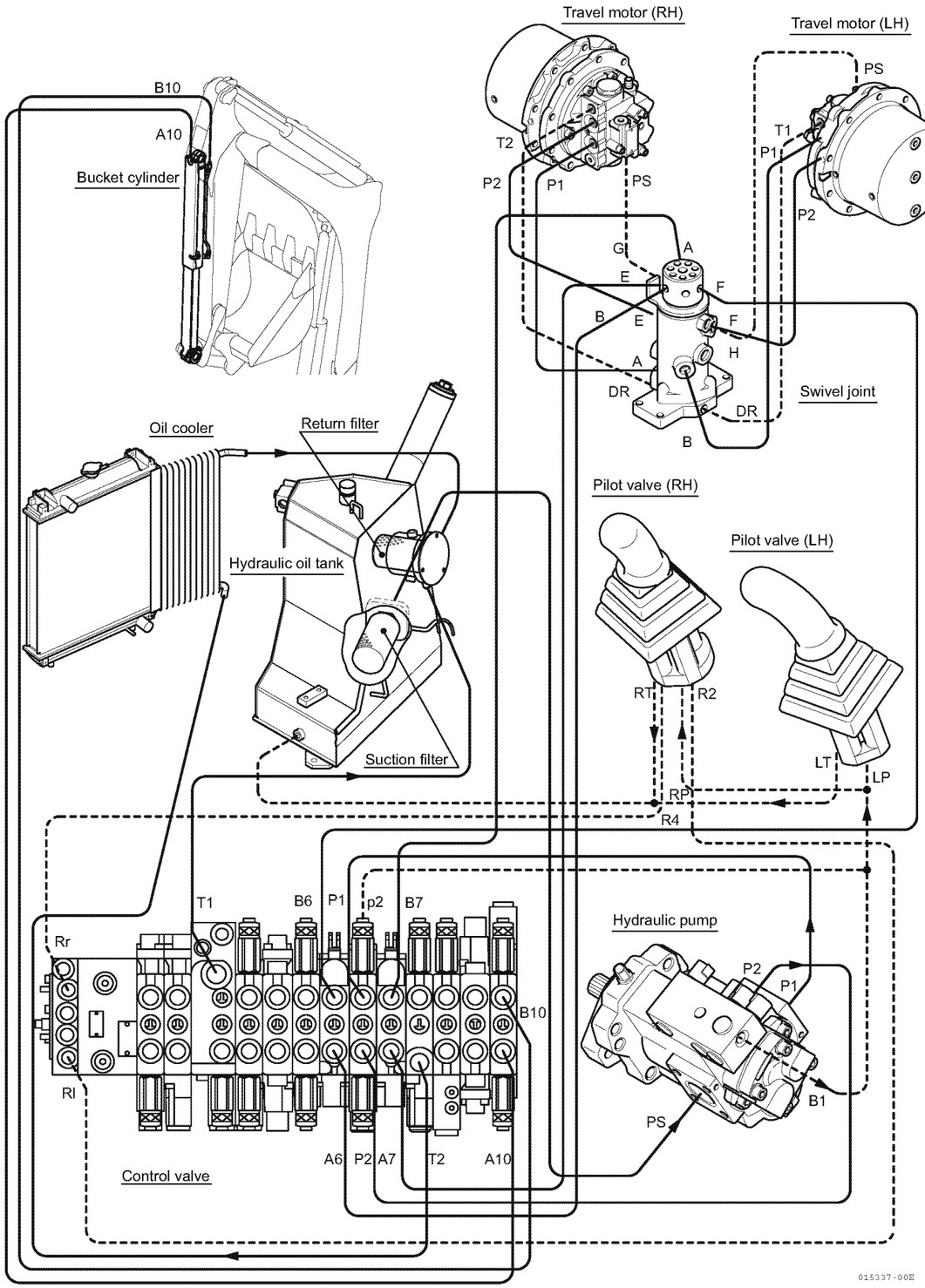
When the bucket is operated while traveling, the spools of travel and bucket sections are moved, so that the pilot oil passages are blocked at the sections. Consequently, the pilot oil pressure at the port p2 of the inlet section raises to move the spool of the inlet section.

Oil Flow from Hydraulic Pump

The pilot oil moves the spool of the parallel-flow divider to the neutral position to let the oil from the gear pump P3 flow into the arm section prior to the boom section.



5. HYDRAULIC SYSTEM



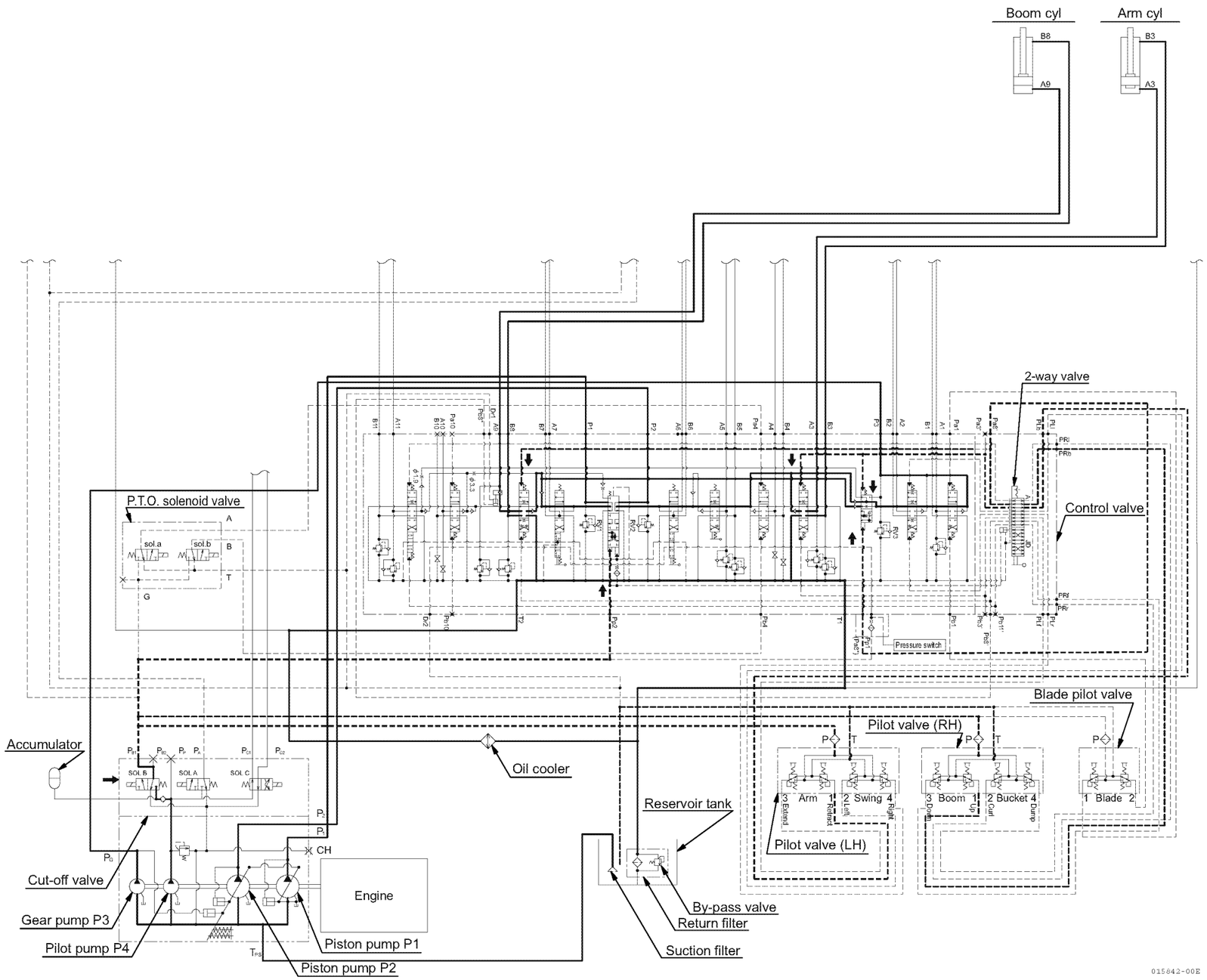
5-3-10 Simultaneous Operation of Boom Up and Arm Retract

Oil Flow from Hydraulic Pump

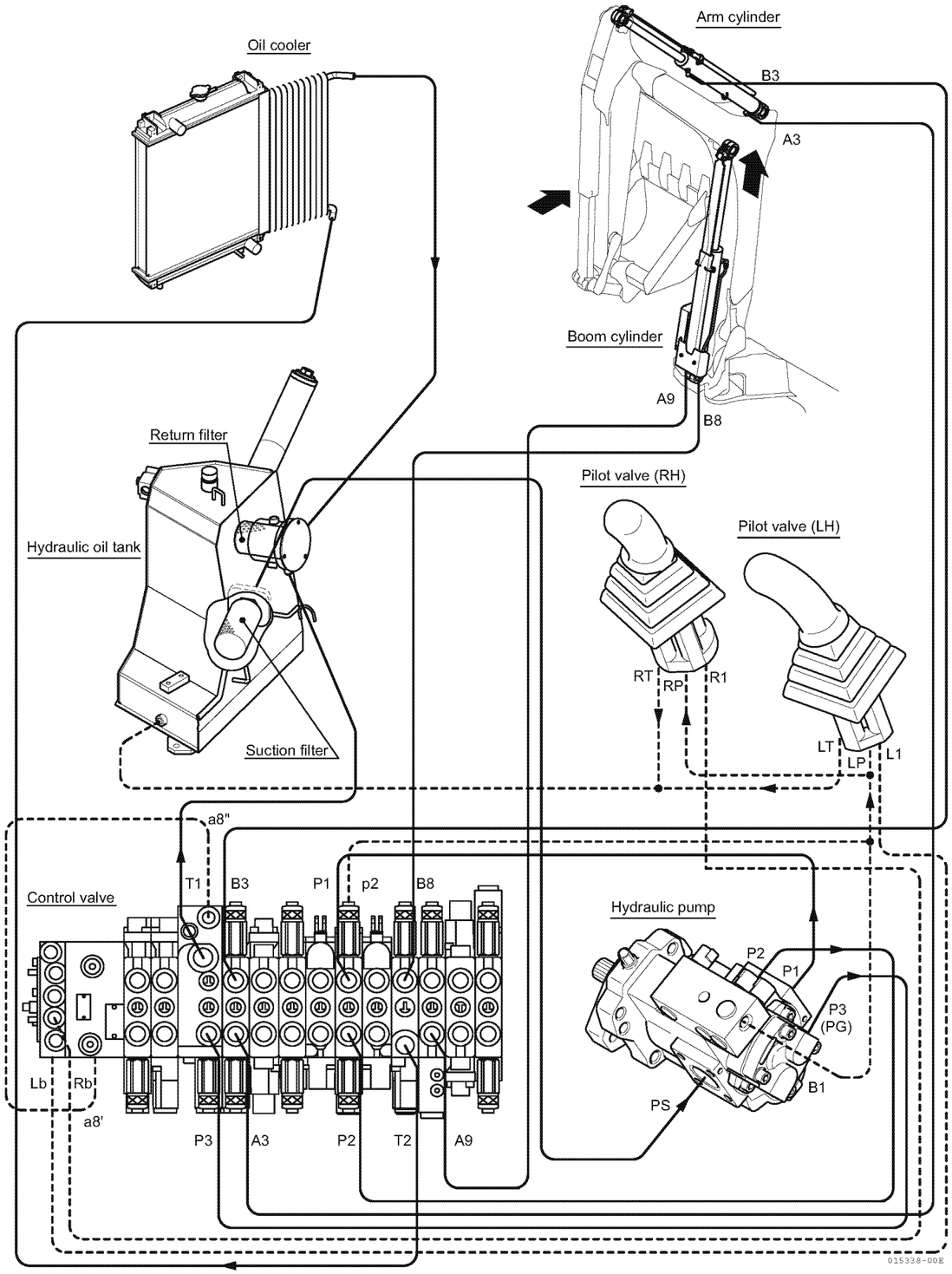
If the arm control lever is pulled back to retract the arm while the boom control lever is pulled back to raise the boom, the parallel-flow divider receives the same pilot oil pressure from the ports a8'' and Lb to keep the spool in the neutral position.

At that time, the oil from the gear pump P3 is combined with the oil to the arm cylinder prior to the boom cylinder to increase the speed of the Arm Retract operation.

Refer to Section "5-3-1 Boom" and Section "5-3-2 Arm" for the oil flow with regard to the boom and arm cylinders.



5. HYDRAULIC SYSTEM

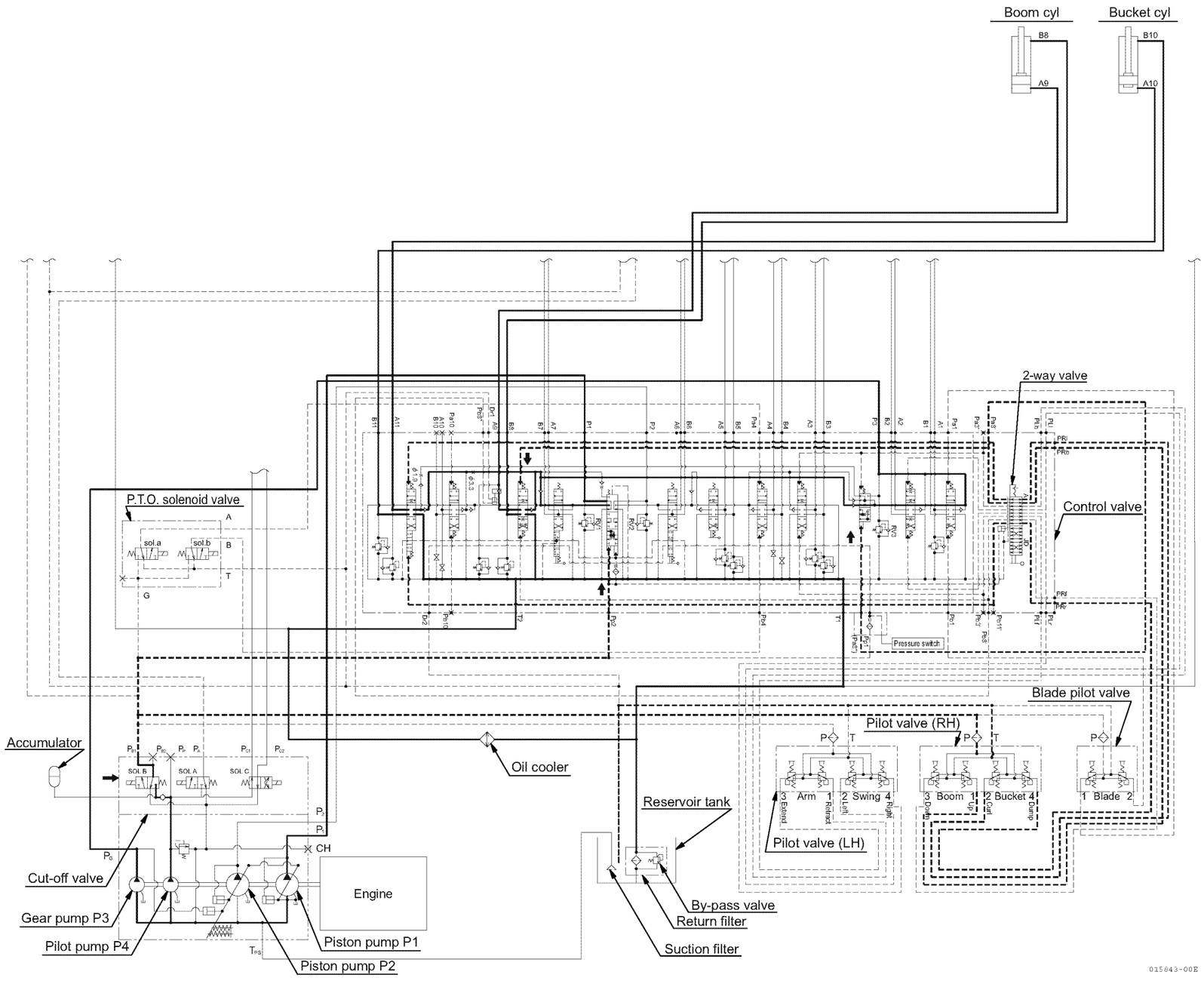


5-3-11 Simultaneous Operation of Boom Up and Bucket

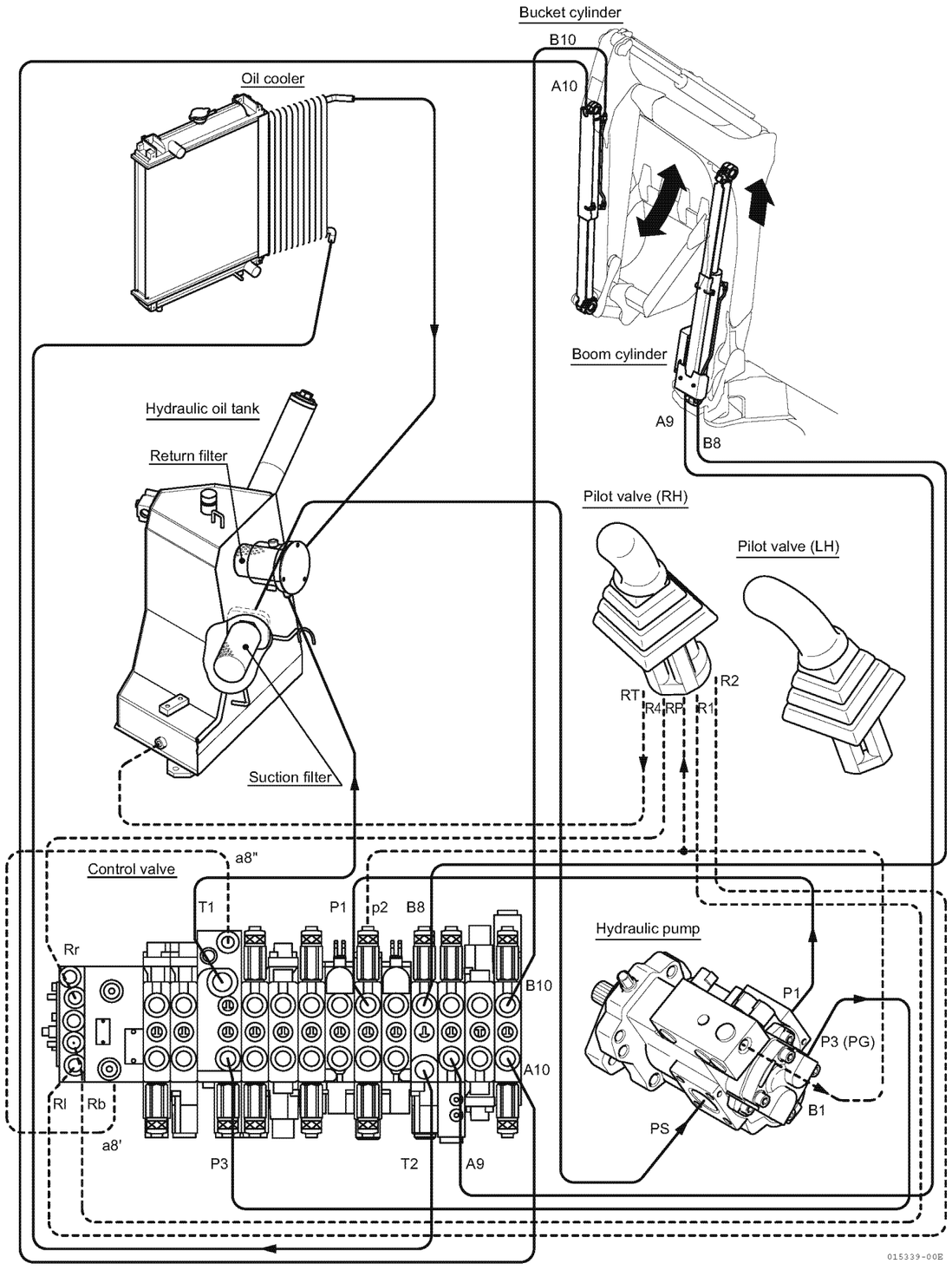
Oil Flow from Hydraulic Pump

A throttle ([Ø0.13 in. [3.3 mm]) is installed in the parallel passage in the bucket section so that the oil can flow more smoothly to the boom section when the bucket control lever is moved while the boom with a heavy load is being raised. Therefore, the boom and the bucket can operate simultaneously.

Refer to Section "5-3-1 Boom" and Section "5-3-3 Bucket" for the oil flow with regard to the boom and bucket cylinders.



5. HYDRAULIC SYSTEM



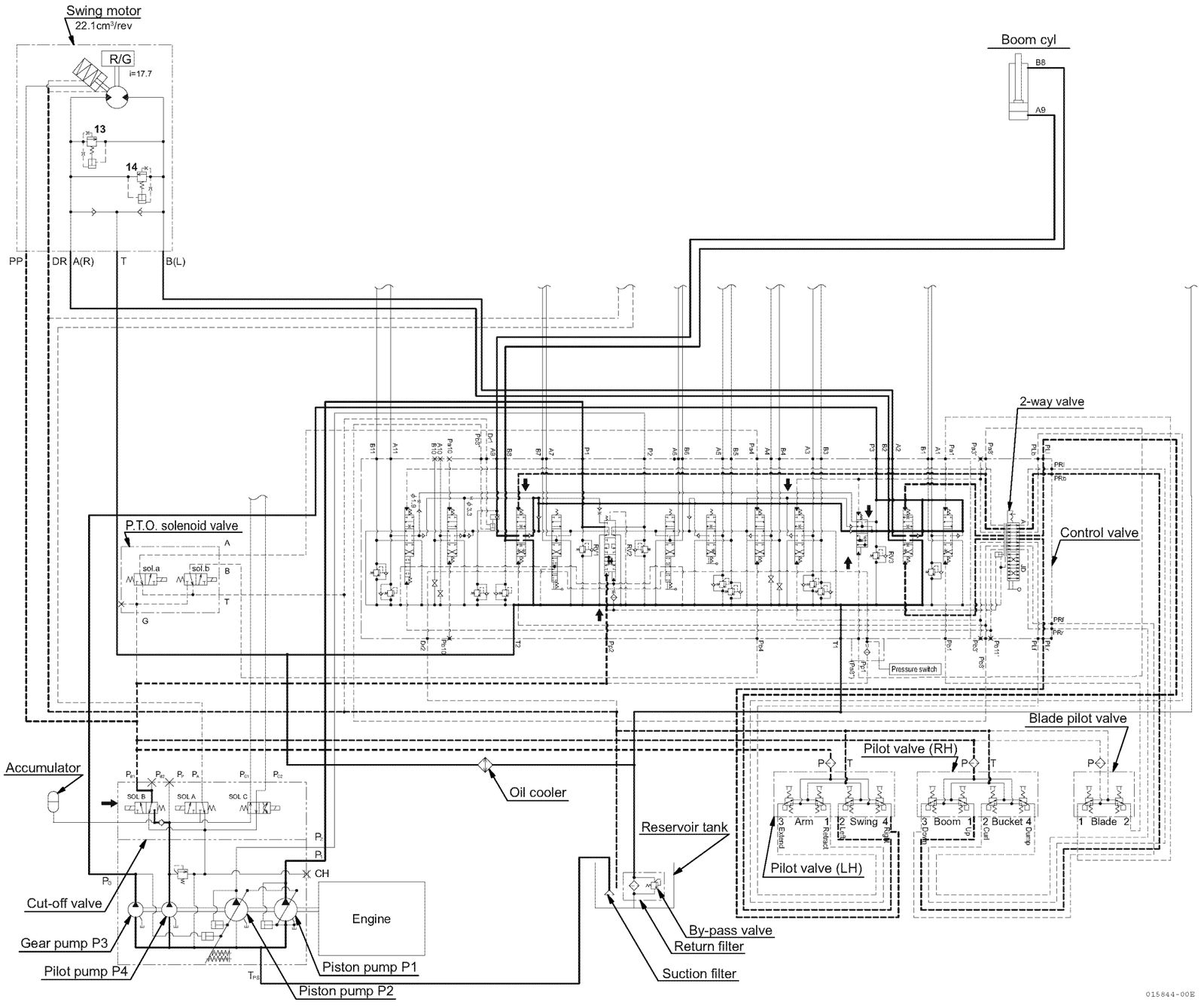
5-3-12 Simultaneous Operation of Boom Up and Swing

Oil Flow from Hydraulic Pump

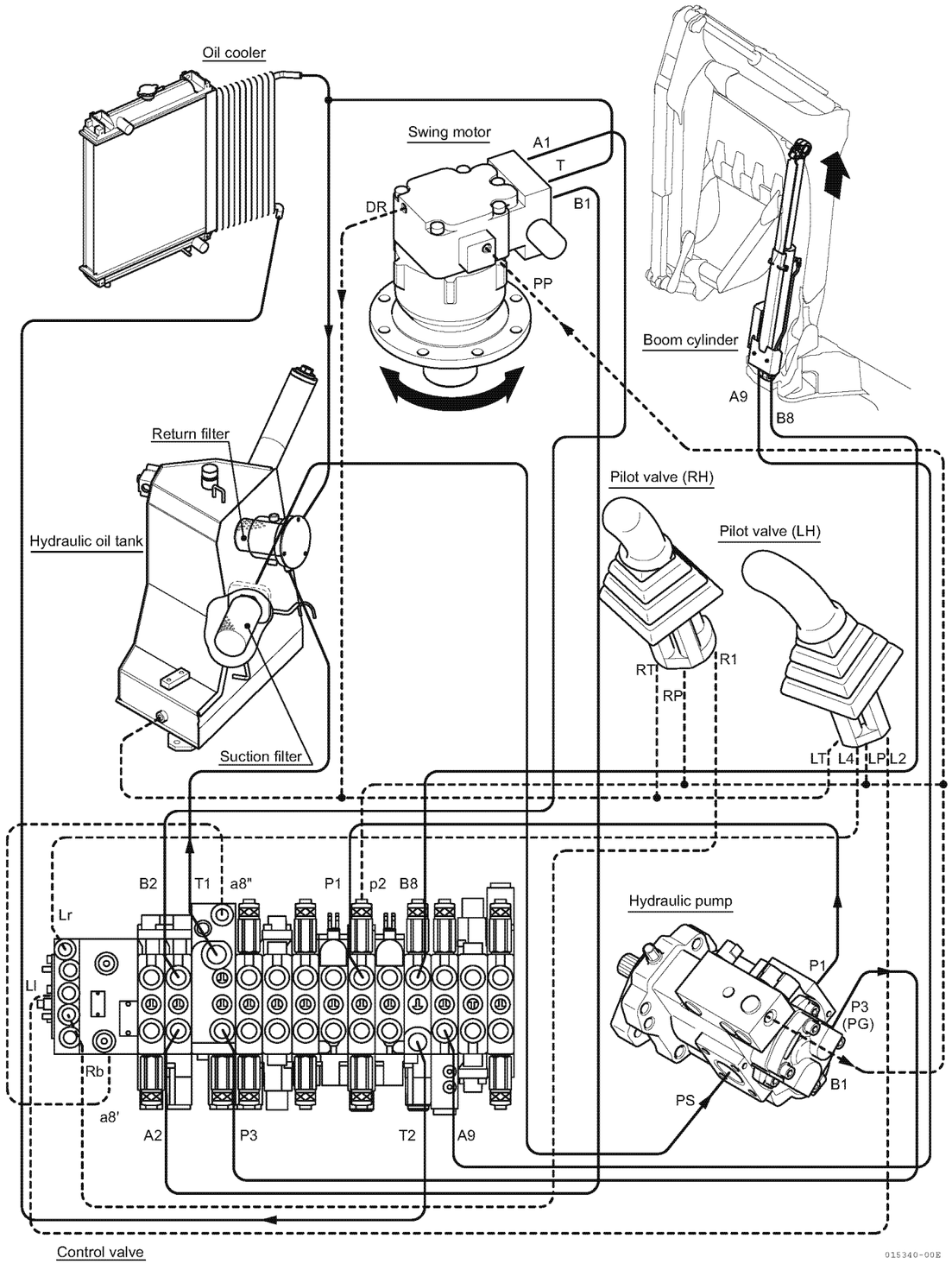
The oil from the gear pump P3 flows to the port P3 of the parallel-flow divider and is divided into two oil flows. One of them flows to the swing section through the parallel passage, and the other flows to the boom section through the parallel passage to combine with the oil from the piston pump P1.

Throttles and a check valve are installed in the swing section so as to match the swing speed to the boom-up speed.

Refer to Section "5-3-1 Boom" and Section "5-3-4 Swing" for the oil flow with regard to the boom cylinder and the swing motor.



5. HYDRAULIC SYSTEM

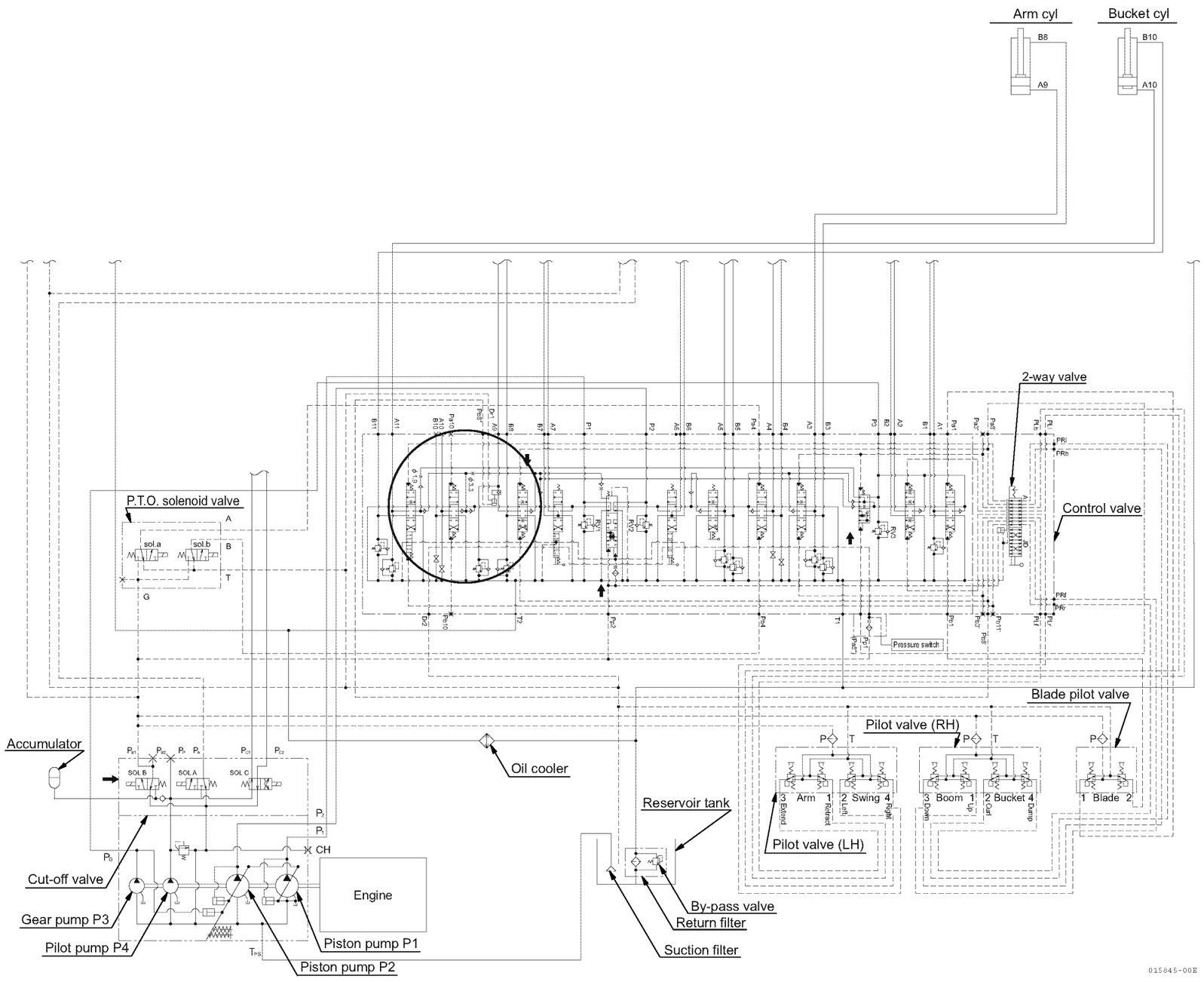


5-3-13 Simultaneous Operation of Arm and Bucket

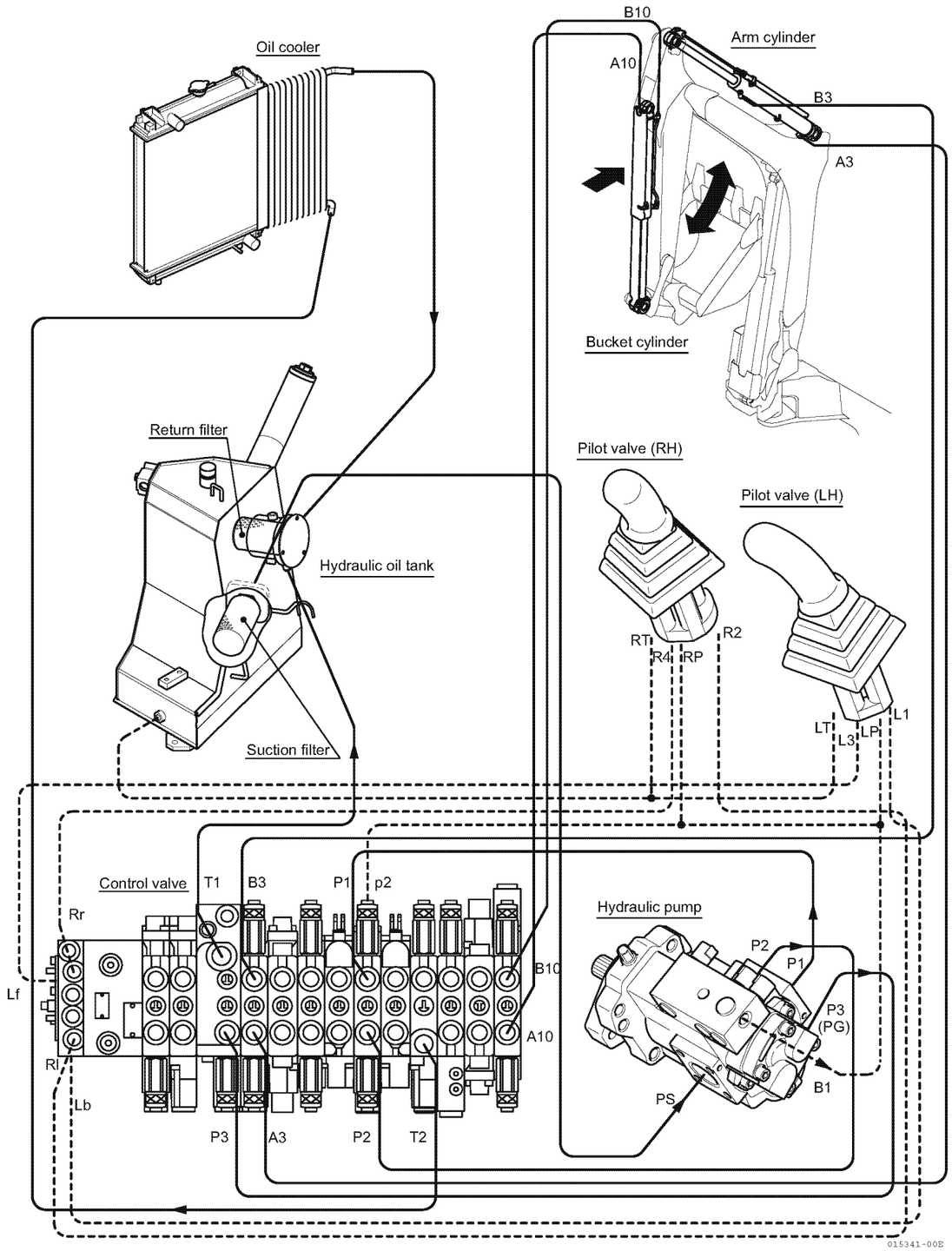
Oil Flow from Hydraulic Pump

When the arm is given a heavy load, the horsepower control shift of the gear pump P3 works to decrease the discharge volume of the piston pump P1, so the bucket speed slows down. To make up for the bucket speed reduction, the oil from the gear pump P3 flows through the parallel-flow divider and the parallel passage to the bucket section and combines with the oil from the piston pump P1.

Refer to Section "5-3-2 Arm" and Section "5-3-3 Bucket" for the oil flow with regard to the arm and bucket cylinders.



5. HYDRAULIC SYSTEM



5-3-14 Hydraulic P.T.O.

The P.T.O. operation is controlled by the switch on the RH lever or the P.T.O. foot switch.

1) Oil Flow from Hydraulic Pump

Turn the knob on the P.T.O. return selector valve to select single or double acting of the P.T.O.

2) Single Acting P.T.O.

When the left position of the lever switch or the foot switch is pressed, the solenoid of the P.T.O. solenoid valve SOL b is exited to move its spool. The oil from the pilot pump P4 flows through the port B1 of the cut-off valve, and the port B of the P.T.O. solenoid valve to the port b4 of the P.T.O. section to move its spool.

Oil Flow from Hydraulic Pump

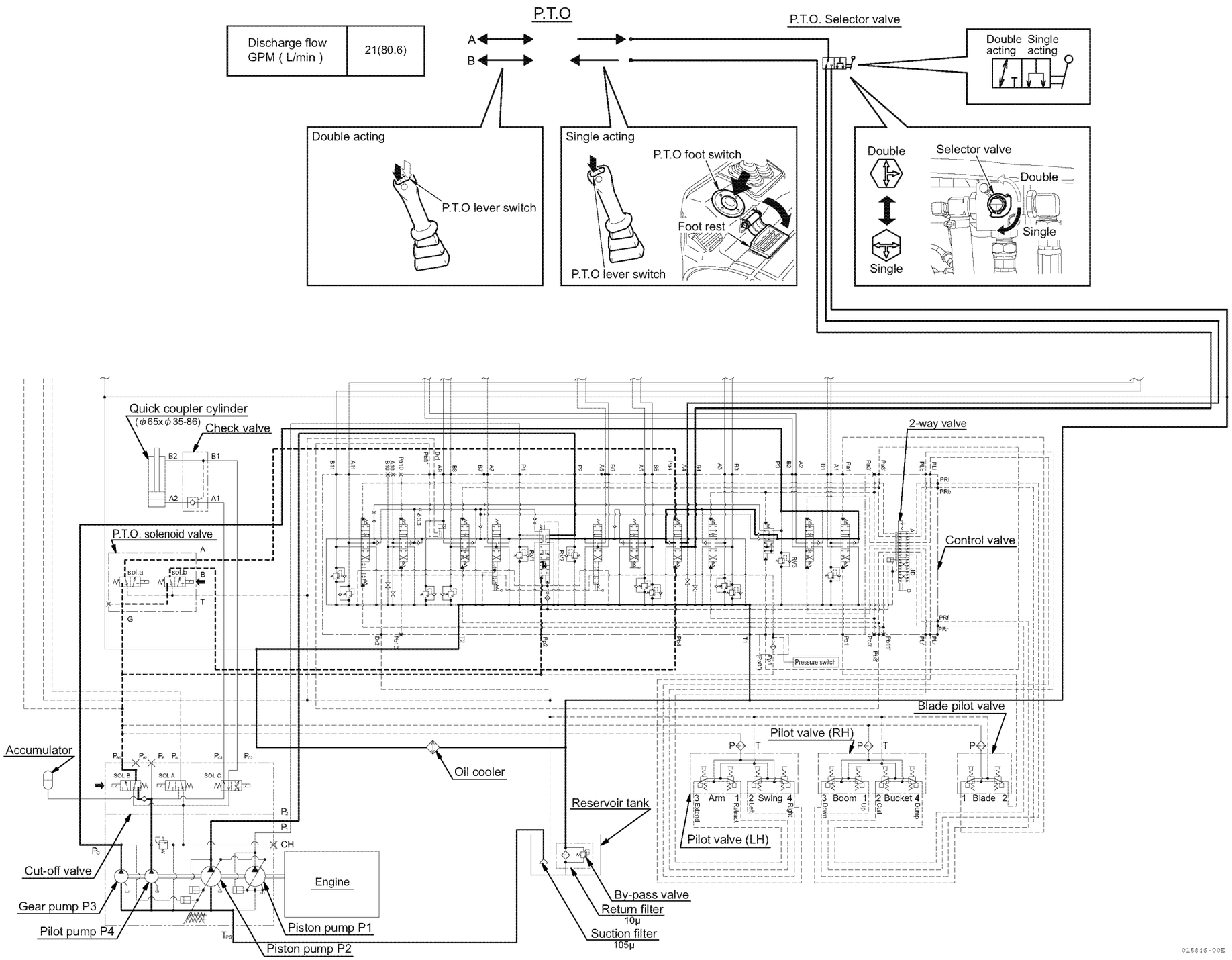
The oil from the piston pump P2 flows to the P.T.O. section through the port P2 of the inlet section. The oil from the gear pump P3 flows through the parallel-flow divider section and the parallel oil passage to the P.T.O. section and is combined with the oil from the piston pump P2. The combined oil flows to the port B4 of the P.T.O. section.
Some return oil directly flows back to the reservoir and the remaining returns through the port A4 of the P.T.O. section and the port T1 or T2 and the oil cooler to the reservoir.

3) Double Acting P.T.O.

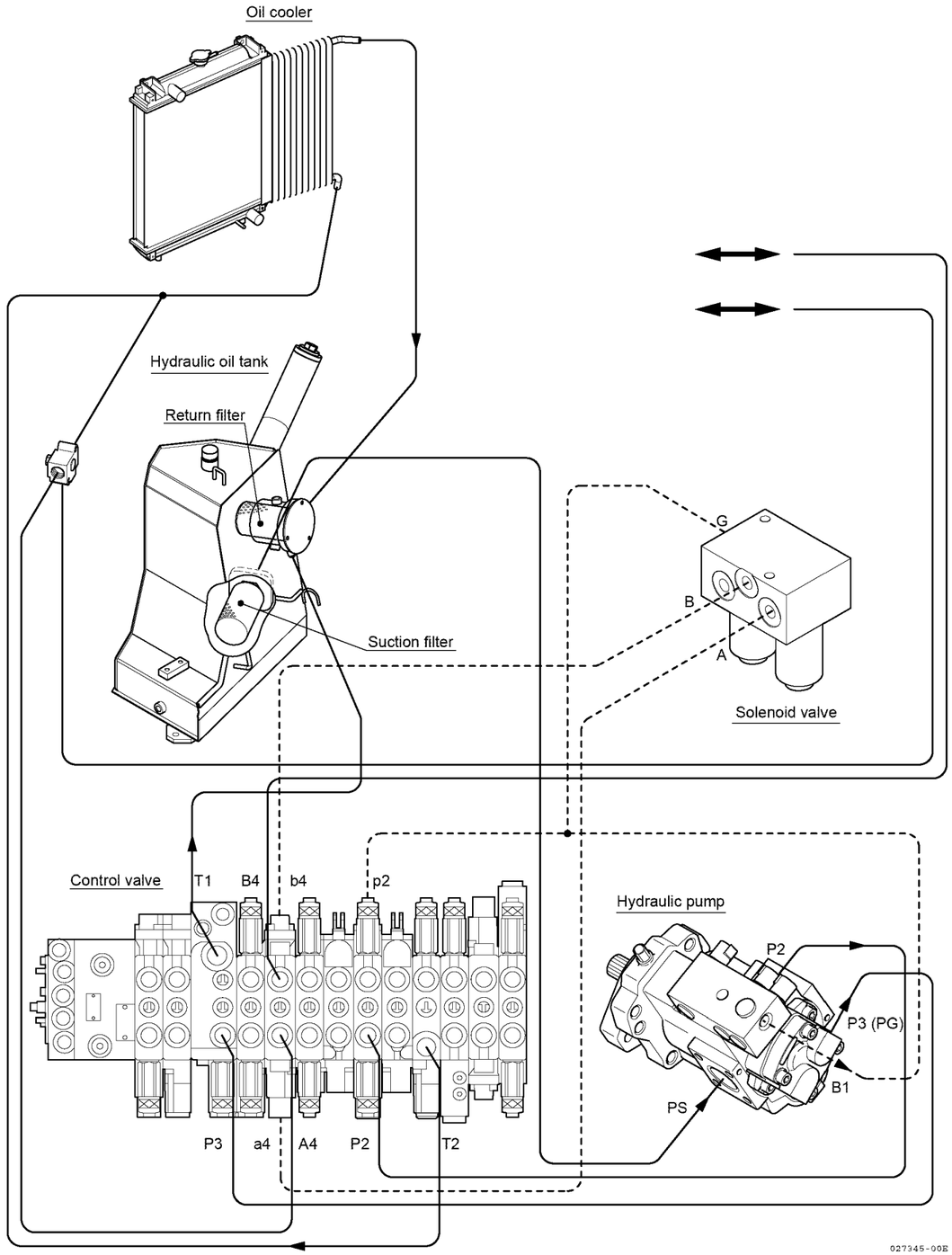
When the left position of the lever switch is pressed, oil flow is the same as that when the single acting P.T.O. is selected.
When the right position of the lever switch is pressed, the solenoid of the P.T.O. solenoid valve SOL a is exited to move its spool. The oil from the pilot pump P4 flows through the port A of the P.T.O. solenoid valve to the port a4 of the P.T.O. section to move its spool.

Oil Flow from Hydraulic Pump

When the right position of the lever switch is pressed, oil flows in the opposite direction to that when the left position is pressed.



5. HYDRAULIC SYSTEM



5-3-15 Quick Coupler

The quick coupler is operated by turning the control switch to the mounting or dismounting position.

Oil Flow from Hydraulic Pump

1) Control Switch in Mounting Position

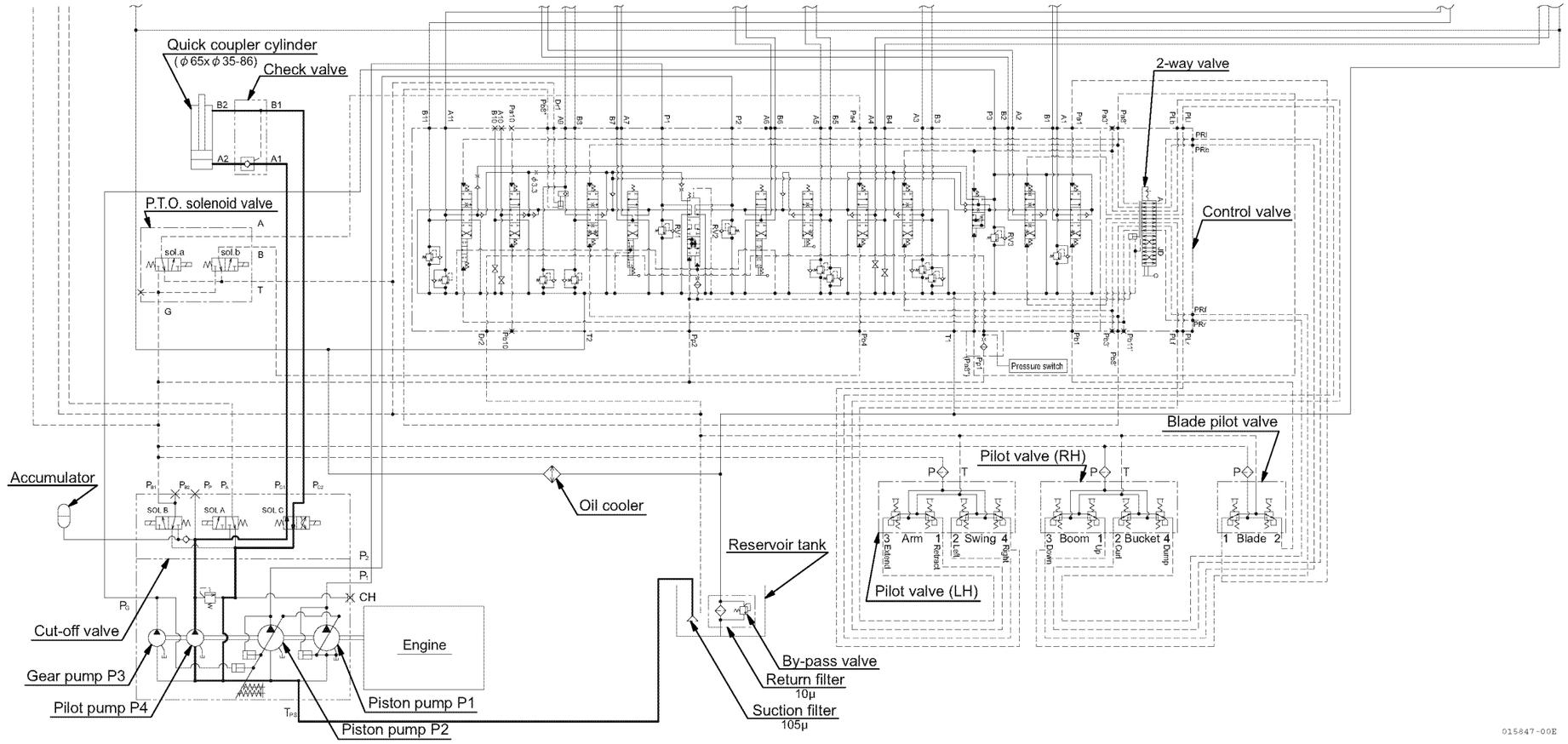
The oil from the pilot pump P4 flows through the port C1 of the cut-off valve and the operate check valve to the bottom side of the quick coupler cylinder to extend its cylinder rod.

The return oil flows through the operate check valve and the port C2 of the cut-off valve to the suction circuit of the pilot pump P4.

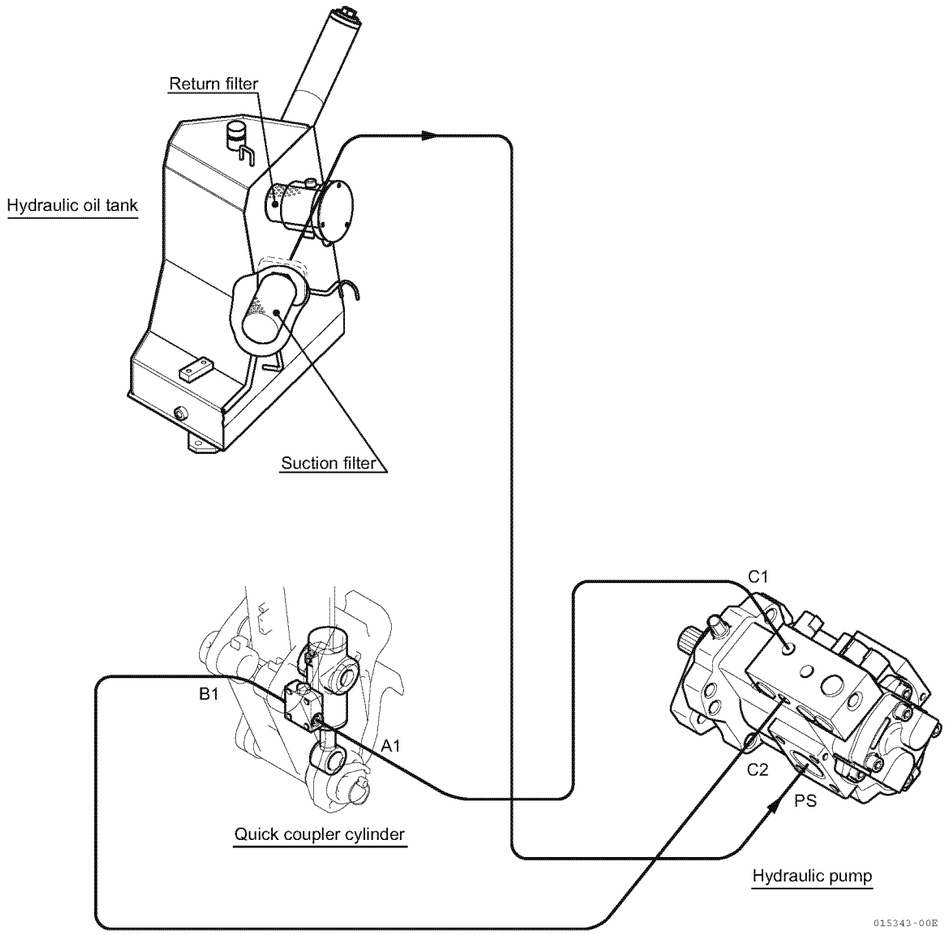
2) Control Switch in Dismounting Position

The oil from the pilot pump P4 flows through the port C2 of the cut-off valve and opens the check valve in the operate check valve to flow to the rod side of the quick coupler cylinder, so that the cylinder rod is retracted.

The return oil flows through the operate check valve and the port C1 of the cut-off valve to the suction circuit of the pilot pump P4.



5. HYDRAULIC SYSTEM



5-4 Pressure Adjustment

5-4-1 Relief Valves

1) Conditions

(1) Engine : rated speed
(2) Hydraulic oil temperature : 122 to 140 °F (50 to 60 °C)
(3) Pressure gauge capacity : 5000 to 6000 PSI (35 to 40 MPa)

2) Relief Valve Specifications

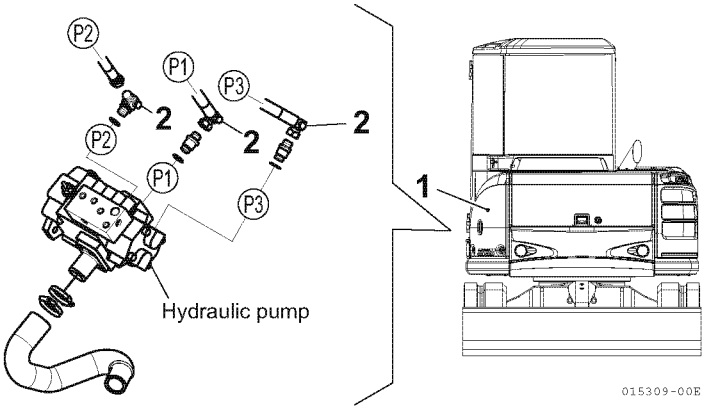
[Unit : PSI (MPa) at GPM (L/min)]

Valve		Pump	Set pressure	
			ViO45-5 ViO45-5B	ViO55-5 ViO55-5B
System relief valve	R1	Piston pump P1	3128.4 (21.6) at 8.0 (30)	3555.0 (24.5) at 8.0 (30)
	R2	Piston pump P2	3128.4 (21.6) at 8.0 (30)	3555.0 (24.5) at 8.0 (30)
	R3	Gear pump P3	3128.4 (21.6) at 8.0 (30)	3555.0 (24.5) at 8.0 (30)
Circuit relief valve	Boom (rod end)	Piston pump P1	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Boom (bottom end)	Piston pump P1	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5) *1 4264.1 (29.4) at 1.3 (5) *2
	Arm (rod end)	Piston pump P2	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Arm (bottom end)	Piston pump P2	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Bucket (rod end)	Piston pump P1	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Bucket (bottom end)	Piston pump P1	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Boom swing (rod end)	Piston pump P2	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Boom swing (bottom end)	Piston pump P2	3555.0 (24.5) at 1.3 (5)	3981.6 (27.5) at 1.3 (5)
	Blade (rod end)	Gear pump P3	2133.0 (14.7) at 10.5 (40)	2133.0 (14.7) at 10.5 (40)

*1: ViO45-5 S/N 50501 to 50591, ViO55-5 S/N 50501 to 50800
*2: ViO45-5 S/N 50592 and above, ViO55-5 S/N 50801 and above

3) Measuring Points

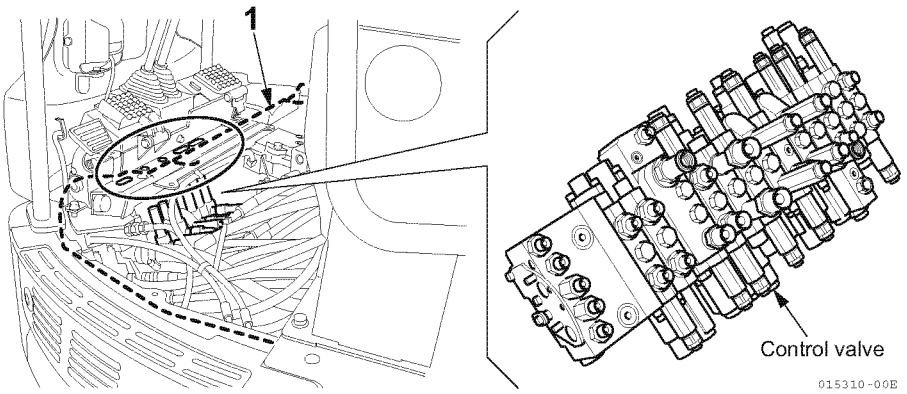
(1) Open the bonnet L **1**.
(2) Remove the plugs (BSPT 1/8) **2** and install the oil pressure gauge.



4) Adjustment Procedure

(1) Remove step **1**.

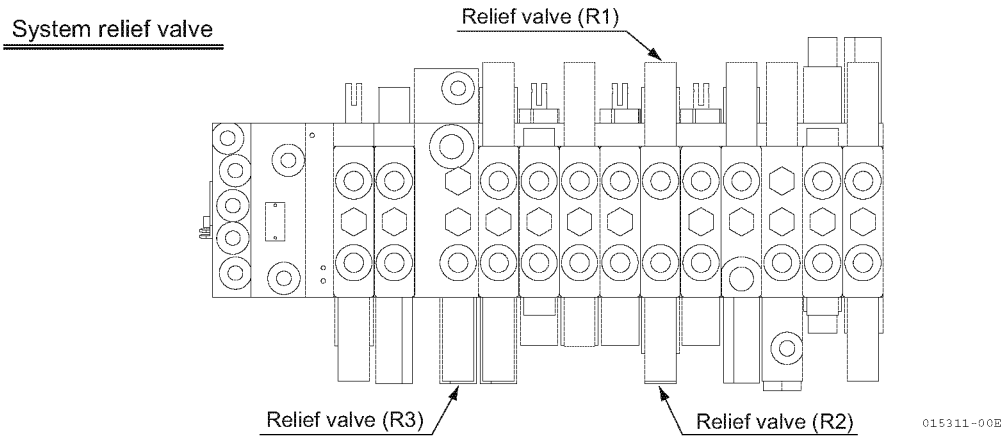
(2) Use hex bar wrench through the holes in the circled area to adjust pressure for the relief valves near the floor.



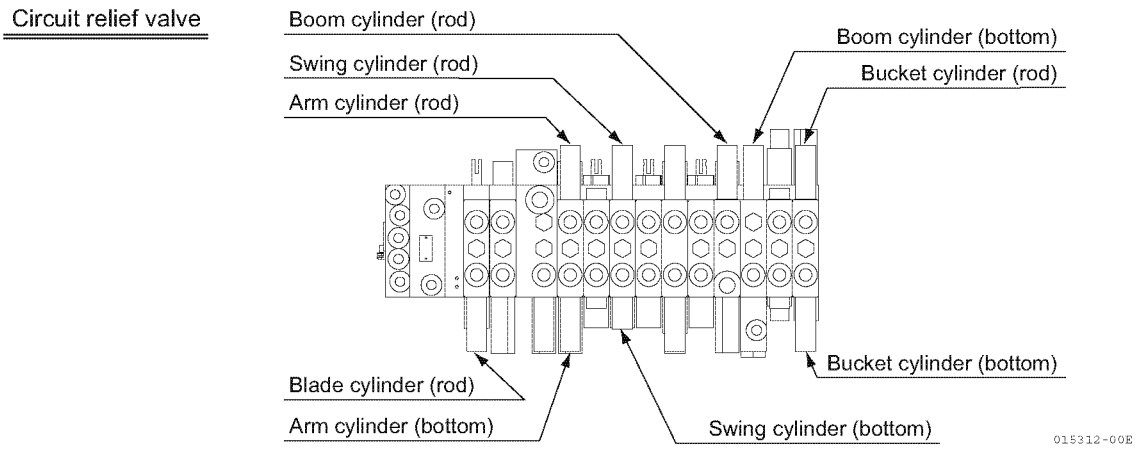
(3) To check the pressure of the system relief valve R1 (for the piston pump P1) in the control valve, retract the bucket cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.

(4) To check the pressure of the system relief valve R2 (for the piston pump P2), retract the arm cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.

(5) To check the pressure of the system relief valve R3 (for the gear pump P3), extend the blade cylinder to its stroke end, hold the lever and read the gauge. Adjust the pressure if necessary.



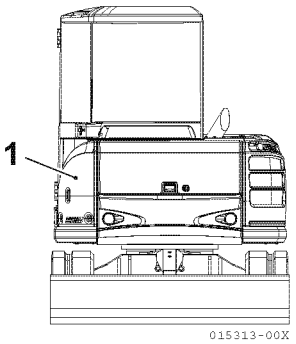
(6) To adjust the pressure of each circuit relief valve, extend or retract the cylinder to its stroke end, hold the lever and read the gauge. Whether the pressure of the circuit relief valve is lower than that of the system relief valve can be read on the gauge.
Increase the pressure of the system relief valve and that of the circuit relief valve by turns, and lock the adjust screw when the specified pressure of the circuit relief valve is obtained. Then lower the pressure of the system relief valve to the specified pressure and lock the adjust screw.



5) Pressure Change by One Turn of Adjust Screw

	Pressure change PSI (MPa)	Number of adjust screw turns	Tightening torque for lock nut ft·lbf (N·m)
System relief valve	1740 (12.0)	1/1	14.47(19.6)
Circuit relief valve			

5-4-2 Swing Brake Valve

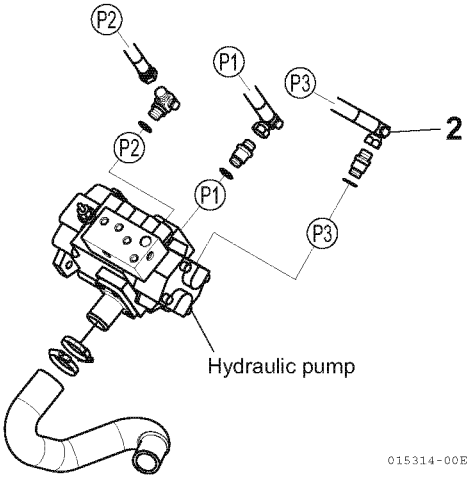


1) Conditions

(1) Engine : rated speed
(2) Hydraulic oil temperature : 122 to 140 °F (50 to 60 °C)
(3) Pressure gauge capacity : 5000 to 6000 PSI (35 to 40 MPa)
(4) Set pressure : 3130 (21.6 MPa)

2) Measuring Procedure

(1) Open the bonnet L **1**.
(2) Remove the plug (BSPT 1/8) **2** to install the pressure gauge.
(3) Fix the upper structure and move the swing lever to the right and the left, hold the lever with relief pressure applied and read the gauge.



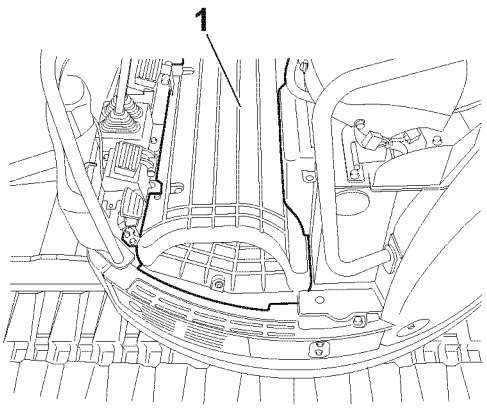
3) Adjustment Procedure

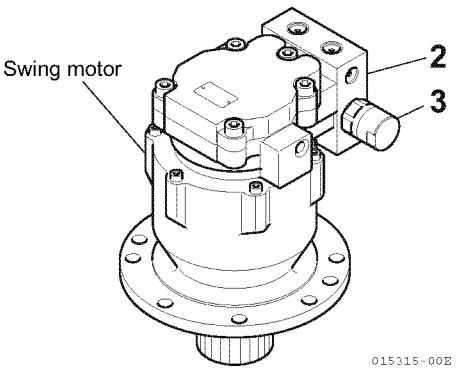
(Relief Valve Replacement Procedure)

Since the relief valve is a fixed-pressure type, replace the relief valve assembly with a new one if the relief pressure needs to be adjusted.

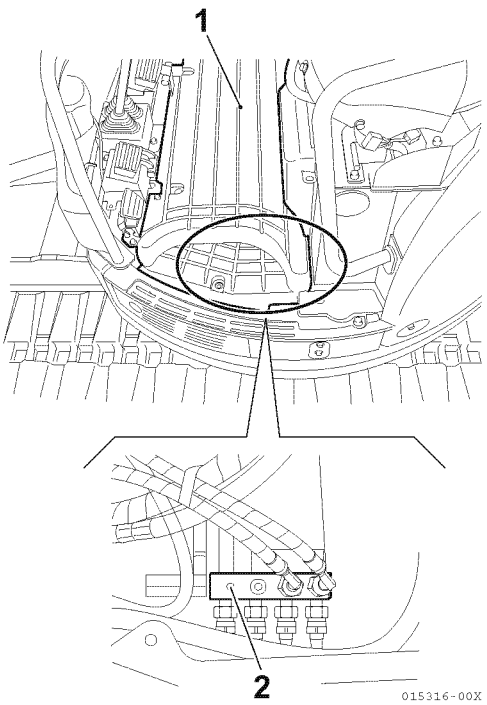
(1) Remove the step **1**.
(2) Remove the relief valve assembly **4** from the brake valve **3**.

Tightening torque for relief valve
95.0 to 123.0 ft·lbf (127.5 to166.7 N·m)





5-4-3 Cut-Off Valve



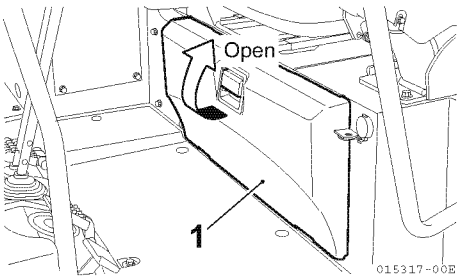
1) Conditions

(1) Engine : rated speed
(2) Hydraulic oil temperature : 122 to 140 °F (50 to 60 °C)
(3) Pressure gauge capacity : 1500 PSI (10 MPa)
(4) Set pressure : 569 PSI (3.9MPa)

2) Measurement Procedure

(1) Open the engine hood A **1**.
(2) Remove the plug (BSPT 1/8) **2** for the hose connector and install the pressure gauge.
(3) Move the lock lever to the "UNLOCK" position, and read the gauge.

3) Pressure Adjustment Procedure



(1) Remove the grill assembly **1**.
(2) Remove the plug (with O-ring) **2**.
(3) Increase or decrease the number of shims **3** to adjust the pressure to the specified value.

Pressure change with a shim

Pressure change	Tightening torque for lock nut
28.4 to 35.6 PSI (0.2 to0.25 MPa)	21.7 ft·lbf (29.4 N·m)